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Proceedings of the Forty-first Annual Meeting of the American Association of Economic Entomologists

(*Continued from page 213*)

PRESIDENT W. B. HERMS: The next paper will be by C. H. Ballou.

EFFECTS OF GERANIUM ON THE JAPANESE BEETLE

By CHARLES H. BALLOU, *Agent, U. S. Bureau of Entomology*

ABSTRACT

Effects of the ingestion of geranium on the Japanese beetle, *Popillia japonica*, are noted. The action of this plant on the digestive tract of the beetle appears to be of a highly corrosive nature.

Japanese beetles[1] feed upon the flowers of our cultivated geraniums (*Pelargonium* spp.), and, to a lesser extent, upon the foliage also. Early in 1920 J. J. Davis[2] reported that "beetles, apparently dead, were usually to be found lying on the ground beneath geraniums, but when placed in boxes they invariably came to life within 24 hours. Evidently geranium acts as a narcotic to the beetles." The writer is informed by L. B. Smith that in 1921 he and T. H. Frison observed that many of the beetles beneath the plants were really dead.

During the summer of 1928 some preliminary experimental data were obtained relative to the effects on the Japanese beetle from feeding on geraniums. Observations were made by two methods. First, beetles were confined in cages with geraniums to determine the effects of feeding on these plants. As a control, other beetles were confined in cages with their favorite food plant, smartweed (*Polygonum pennsylvanicum*). Second, beetles that had become paralyzed from feeding on geraniums in outdoor beds were placed in cages for observation. The latter cages were provided with smartweed to serve as food for the beetles that recovered. As a control on the paralyzed beetles, or on beetles that

[1] *Popillia japonica* Newman.

[2] Davis, J. J. The green Japanese beetle. N. J. State Dept. of Agri. Circ. 30, pp. 33, figs. 18, map. 1920.

ate but a very small quantity of geranium, healthy beetles were confined in starvation cages, which were provided with pots of soil only.

When beetles were confined in cages kept continuously in the shade and supplied with flowerless geraniums, they ate the leaves to the extent of 10 per cent, but not as many of them died as was the case in the starvation control cages. When confined in cages exposed to sunlight, however, there was a marked difference, as was shown in another test. In one cage containing a flowerless plant and so exposed, the mortality amounted to 44 per cent on the fifth day, by which time the geranium foliage had been 95 per cent eaten. At this time the mortality in the smartweed control cage was only 5 per cent. In two cages containing flowering plants, of which the entire flower cluster and a considerable part of the foliage had been eaten, the mortality was 60 and 80 per cent, respectively. All the cages in this test, including the control, received the same exposure to sunlight.

TABLE 1. EFFECTS OF FEEDING UPON GERANIUM FOLIAGE IN SHADE

Geranium, 3 cages; smartweed control, 1 cage; starvation control, 5 cages. Fifty beetles per cage.

Day of test	Percentage of Geranium Eaten	Number of Beetles Dead[1]			Percentage of Beetles Dead		
		Geranium Cages	Smartweed Cages	Starvation Cages	Geranium Cages	Smartweed Cages	Starvation Cages
4	0	0	0	1	0	0	0.4
5	2	9	2	35	6	4	14
6	10	89	2	218	59	4	85

[1]In all tables the number and percentage of beetles dead on any day includes all that had died from the beginning of the test to that time.

The results of these tests indicate that the poisonous effect of geranium to the Japanese beetle is greater when the feeding is done on plants exposed to sunlight than when it is done on plants kept in the shade, and that the flower is more toxic than the foliage.

TABLE 2. EFFECTS OF FEEDING UPON GERANIUMS EXPOSED TO SUNLIGHT

Exposed to sunlight from 9 A. M. to 1 P. M. on the second day of the test only. One hundred beetles per cage.

Day of test	Flowerless Geranium		Pink Geranium			Red Geranium			Smartweed Control
	Percentage of Plant Eaten	Beetles Dead	Percentage of Plant Eaten		Beetles Dead	Percentage of Plant Eaten		Beetles Dead	Beetles Dead
	Leaf		Leaf	Flower		Leaf	Flower		
2	5	0	1	20	0	5	5	0	0
3	85	12	3	80	38	5	95	53	1
4	90	29	5	80	56	5	95	68	2
5	95	44	20	dry	60	5	dry	80	5

In a similar test, in which two cages were kept in the shade until the fourth day, when one was exposed to sunlight from 8 to 9:30 A. M., the results of the exposure were very noticeable at 7 P. M. of the same day, when the evening inspection was made. On the evening of the third day the mortality had amounted to 6 per cent in the cage that was retained in the shade and to 2 per cent in the cage that was subsequently sunned. By the following evening, however, the mortality in the shaded cage had risen only to 14 per cent, while it had risen to 58 per cent in the cage that had been exposed to sunlight.

TABLE 3. COMPARISON OF EFFECTS ON BEETLES FEEDING UPON GERANIUMS EXPOSED TO SUNLIGHT AND UPON SIMILAR PLANTS KEPT IN SHADE

Both controls kept in shade. Fifty beetles per cage.

Day of test	Geranium Kept in Shade			Geranium Exposed to Sun			Smartweed Control	Starvation Control
	Percentage of Geranium Eaten		Beetles Dead	Percentage of Geranium Eaten		Beetles Dead	Percentage of Beetles Dead	Percentage of Beetles Dead
	Leaf	Flower		Leaf	Flower			
2	0	10	2	0	10	0	0	0
3	0	30	6	trace	80	2	0	2
4	0	85	14	1	95	58[1]	6	18
5	0	100	22	1	100	88	8	50

[1]Exposed to sunlight on the 4th day only, from 8 to 9:30 A. M.; observation made at 7 P. M.

One hundred and sixty-three beetles which had become paralyzed from eating geraniums in flower beds were placed in cages with smartweed, and kept in the shade. Each morning the dead and those which had recovered were removed from the cages. Two hundred and fifty beetles in starvation cages were used as a control. By the second day 30 per cent of the paralyzed beetles had died, while none had died in the starvation controls. By the third day the mortality among the paralyzed beetles had amounted to 38 per cent, and that among the starved beetles to only 0.3 per cent. By the fourth day it had risen to 42 and 9 per cent, respectively. Most of the fatalities among the paralyzed beetles occurred before the third day.

TABLE 4. MORTALITY OF PARALYZED BEETLES COLLECTED FROM THREE GERANIUM BEDS

Day of test	Percentage Mortality of Beetles				
	Paralyzed Beetles				Starvation Control[4]
	Bed A[1]	Bed B[2]	Bed C[3]	Average	
2	22	43	27	30	0
3	35	48	31	38	0.3
4	39	52	36	42	9
5	41	54	40	45	28

[1]63 beetles. [2]48 beetles. [3]52 beetles. [4]250 beetles.

Four hundred and eighty living but paralyzed beetles were placed in cages with smartweed and kept in the shade. Those which died or recovered were removed each day. By the end of 6 hours 34 per cent had recovered and 8 per cent had died; by the end of 24 hours 54 per cent had recovered and 27 per cent had died; by the end of 48 hours 55 per cent had recovered and 44 per cent had died, leaving only 1 per cent still paralyzed. Most of the recoveries took place before the end of the first day, but beetles continued to die in considerable numbers until the third day.

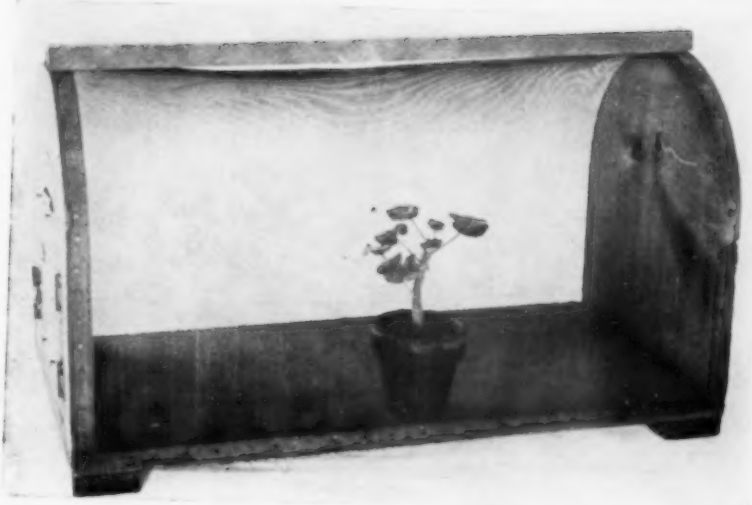
TABLE 5. MORTALITY AND RECOVERY OF 480 LIVING BUT PARALYZED BEETLES COLLECTED FROM GERANIUM BEDS

Time Elapsed After Collection	Beetles Recovered	Beetles Dead	Percentage Recovered	Percentage Dead
6 hours	165	40	34	8
1 day	262	131	54	27
2 days	265	211	55	44

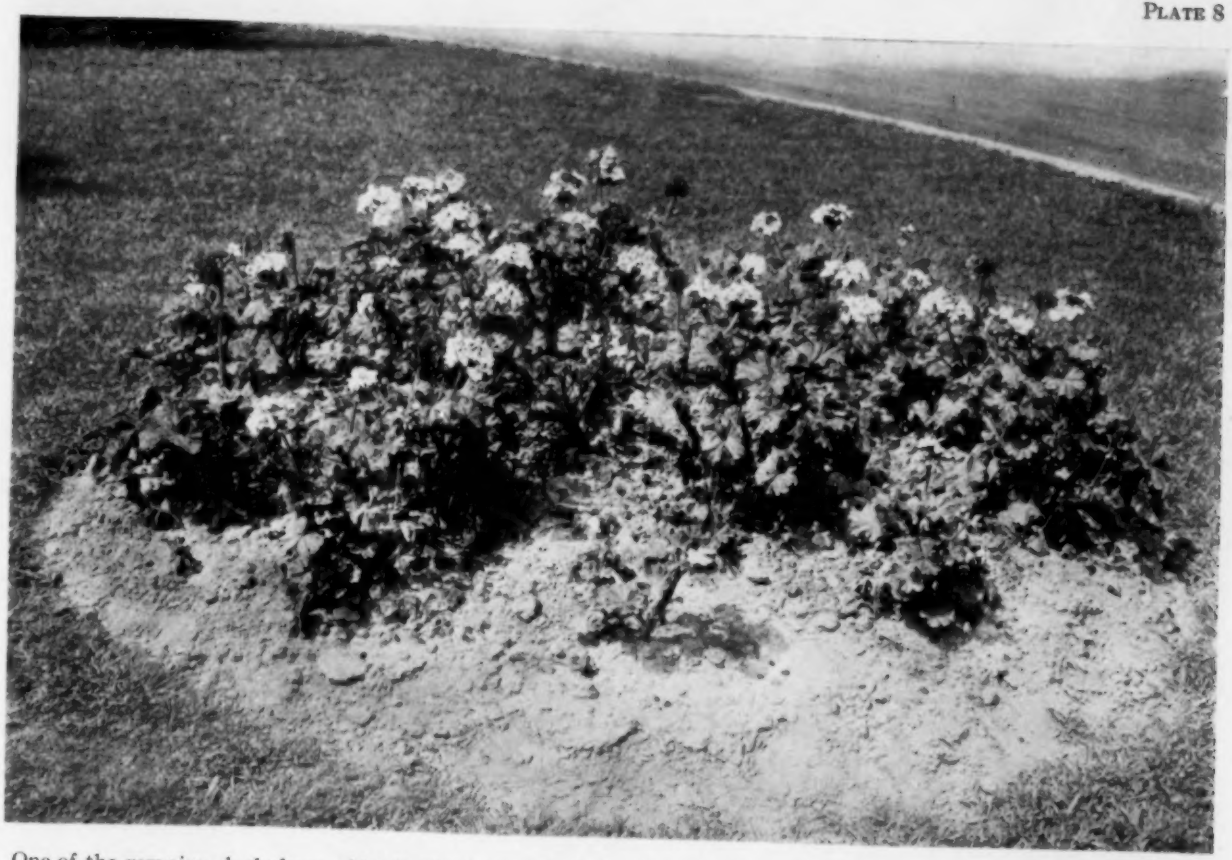
The symptoms of geranium poisoning in the Japanese beetle are very characteristic. Paralysis, which first appears in the hind legs, soon extends to the middle legs, and later to the fore legs. The beetle then lies on its back or a side with the legs rigid, showing no signs of life except occasional movements of the head when disturbed. In a short time the neck becomes rigid, and the beetle appears to be dead. That this is not the case is easily demonstrated, however, by bending the head backward. Although the muscles connecting the head with the thorax are more rigid than those of a dead beetle dried in the sun, they do not break, but yield when pressure is applied. Upon releasing the pressure the beetle immediately draws its head down into its normal position. In the case of a dead beetle, whether as the result of geranium poisoning or from any other cause, the head is not drawn down into position after being bent backward, but remains flexed.

As soon as beetles in the geranium cages died they were turned over to M. C. Swingle of the Japanese Beetle Laboratory for examination. He found that the mid-gut disappeared 24 hours after death, while it merely shrinks and dries in beetles which die of starvation or are killed by cyanide fumes. The ingestion of arsenic is accompanied by disintegration of the mid-gut within 24 hours without putrefactive decomposition. The ingestion of geranium, however, is followed by decomposition accompanied by a strong, fetid odor which suggests bacterial decay. Forty-eight hours after death from geranium poisoning the muscles and the soft contents of the body cavity had completely disintegrated.

PLATE 7



Cage with geranium plant in place



One of the geranium beds from which beetles were collected. Some of the flower heads have been completely destroyed by the beetles. Dead or paralyzed beetles may be seen on the ground and to the right of the plant in the center of the foreground

by the beetles. Dead or paralyzed beetles may be seen on the ground and to the right of the plant in the center of the foreground

Geranium plants showing effects of feeding by Japanese beetles. Beetles may be seen on the flowers, the foliage and the ground beneath the plants

Geraniums partly eaten by Japanese beetles. Dead or paralyzed beetles may be seen on the ground beneath. It will be noticed that a greater proportion of the flowers have been eaten than of the foliage

SUMMARY

Japanese beetles feed on cultivated geraniums. This causes paralysis beginning with the hind legs and progressing cephalad. About 35 per cent of the paralyzed beetles under observation died within 4 days. Most recoveries took place within 24 hours. The flower appears to be more attractive to the beetles and more toxic to them than the foliage, and the effect is heightened when the feeding takes place on plants exposed to sunlight. The mid-gut of beetles dying from eating geraniums is disintegrated within 24 hours and the soft contents of the body cavity within 48 hours.

PRESIDENT W. B. HERMS: The next paper will be by E. N. Cory and P. D. Sanders.

SOIL TREATMENT FOR JAPANESE BEETLE CONTROL

By E. N. CORY and P. D. SANDERS, *College Park, Md.*

(Not received in time for publication)

PRESIDENT W. B. HERMS: The next paper will be by H. C. Hallock.

KNOWN DISTRIBUTION AND ABUNDANCE OF ANOMALA ORIENTALIS WATERHOUSE, ASERICA CASTANEA ARROW, AND SERICA SIMILIS LEWIS IN NEW YORK[1]

By HAROLD C. HALLOCK, *Associate Entomologist,*
United States Department of Agriculture

ABSTRACT

The records include not only the range of *Anomala orientalis*, *Aserica castanea*, and *Serica similis* but notes on their general abundance where they have been found to occur in New York State.

Since 1920, three Oriental beetles which are closely related to the Japanese beetle (*Popillia japonica* Newm.) have made their appearance in the eastern part of the United States. These are the Asiatic beetle (*Anomala orientalis* Waterhouse), the oriental garden beetle (*Aserica castanea* Arrow), and the imported Serica (*Serica similis* Lewis). The Asiatic beetle was first observed in 1920, at New Haven, Connecticut. The oriental garden beetle was first collected in 1921, in New Jersey. The imported Serica was not reported until the summer of 1927, when it was found at Westbury, New York.

[1]Contribution No. 54—Japanese Beetle Laboratory, Moorestown, N. J.

The Asiatic beetle and the oriental garden beetle have become economically important in this country, but they do not appear to be as serious pests in the vicinity of New York City as the Japanese beetle. The imported Serica is still rare in all localities where it is known to

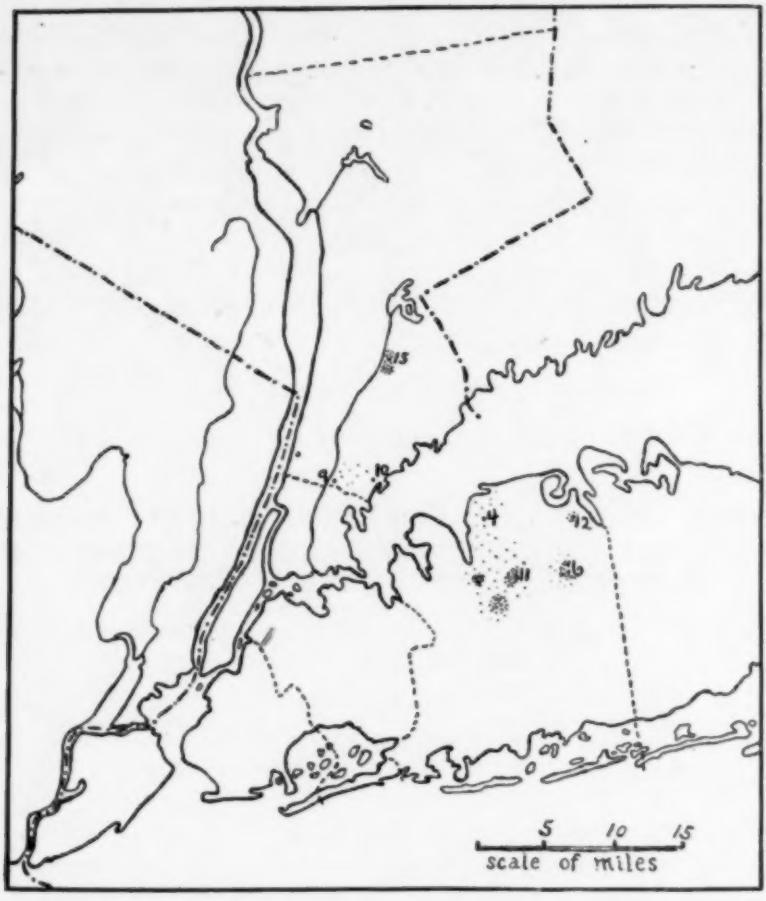


FIG. 5.—Distribution of *Anomala orientalis* in New York State in 1927.

occur in this country. During the years 1927 and 1928 records were kept which include the known distribution and the general abundance of these beetles where they have been found to occur. The records for the New York district are herewith presented.[2]

[2]Many of the records for isolated localities were made by the West Farms office of the Japanese Beetle Quarantine.

The Asiatic Beetle

The Asiatic beetle, *Anomala orientalis*, is known to occur in New York State in five counties: Westchester, Bronx, Queens, Nassau, and Suffolk. There are localities where economic damage has occurred in the New York district (Fig. 5 and 6) which are distinctly separated by areas where the insect can be found only by careful scouting, or where it

Fig. 6.—Distribution of *Anomala orientalis* in New York State in 1928.

is not known to occur. Several small infestations were found in 1928 (Fig. 6) at isolated stations which do not appear to be connected with the denser infestations, and the insect is still rare at these localities. The isolated infestations which are at the most outlying points are located at Bedford Village in Westchester County to the north and near Smithtown Branch in Suffolk County to the east.

The area of lawn turf in New York injured in 1928 was nearly double

that in which injury was reported to occur in 1927. There were two localities, one at Harbor Hill, North Roslyn, and the other at Oyster Bay, where injury was reported in 1927, but in 1928 the turf was not injured at these localities. It is believed that the controlling or checking of the insect in these instances should be credited to the fact that

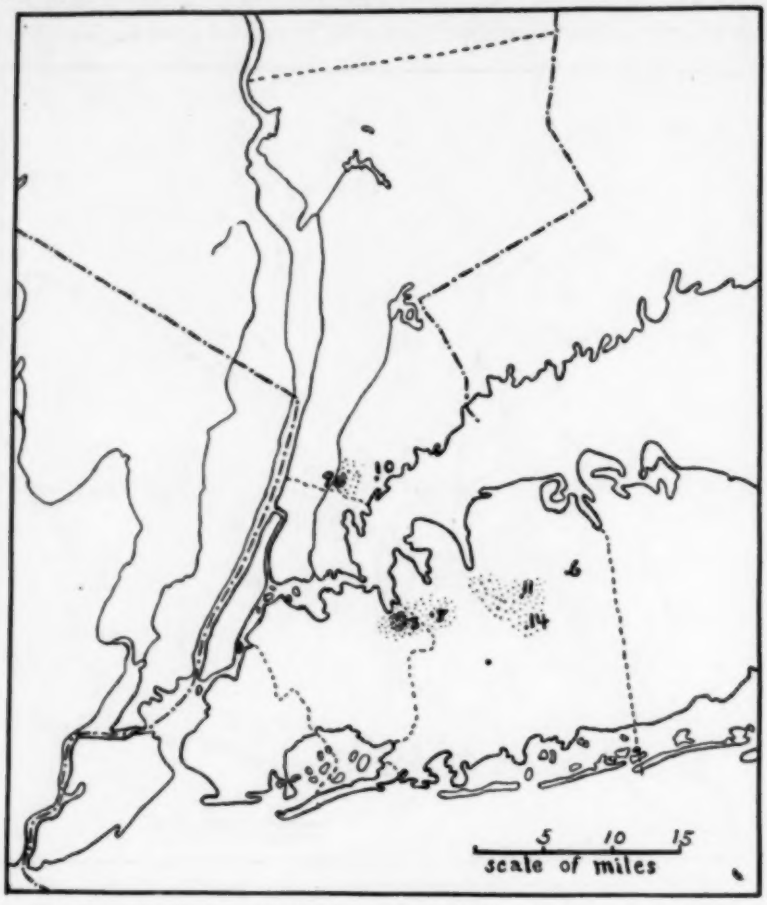


FIG. 7.—Distribution of *Aserica castanea* in New York State in 1927.

the property owners followed recommendations of the United States Department of Agriculture,[3] and used a top dressing which contained 5 pounds of lead arsenate to one bushel of soil for each 1,000 square feet of lawn where the pest was known to occur.

[3]Leach, B. R. Further experiments in the control of Japanese beetle grubs. Bul. U. S. Golf Assoc., Green Section, 8:28–33, illustr. 1928.

The following table shows the degrees of infestation in 1928 at the localities where the beetles were abundant. In the case of the Asiatic beetle it is apparent, from a large number of diggings, that approximately 25 grubs to a square foot of lawn is sufficient to cause injury. Although the average number of grubs observed in heavy infestations was approximately 75 to a square foot, there were eight diggings among those which were made in 1928 where more than 150 grubs were found.

Although lawns have been observed where from one to three acres of turf were ruined, infestations of the Asiatic beetle grub are not evenly distributed in most cases. Some portions of a lawn may be destroyed, while others often appear to be in good condition. As the grubs of this species have been found so rarely in sod lands which were not kept closely mowed, the averages given in the table are derived only from data obtained from observations made in well kept lawns.

GRUB POPULATION OF *Anomala orientalis* AND *Aserica castanea* IN THE NEW YORK AREA, 1928

		Number of Grubs per Square Foot of Turf Examined			
		Anomala orientalis		*Aserica castanea*	
	Locality	Maximum	Average	Maximum	Average
1	Albertson			26	11
2	Clearview			14	8
3	Douglaston			45	22
4	Glen Cove	95	50	82	41
5	Great Neck	1	rare	12	3
6	Jericho	553	78	3	rare
7	Kew Gardens			15	6
8	Lakeville			37	20
9	Mount Vernon	119	41	80	38
10	New Rochelle	115	77		
11	Old Westbury	135	83	90	35
12	Oyster Bay			13	5
13	Queens			7	2
14	Westbury	3	rare	157	42
15	White Plains	78	71		

The locality numbers correspond to the figures on the maps.

THE ORIENTAL GARDEN BEETLE

The district known to be infested by the oriental garden beetle, *Aserica castanea*, in New York is confined to two localities, one extending along the northern half of Nassau and Queens Counties, the other a small area on each side of the boundary between Westchester and Bronx Counties. Within these localities there are five centers (Fig. 8) where injury has been reported, although all the localities on

Long Island where heavy infestations occur are connected by a general light infestation. This beetle has also been found at a few isolated stations in Nassau County.

As the oriental garden beetle flies at night and is attracted by light, an electric-light trap was kept burning all night during the summer

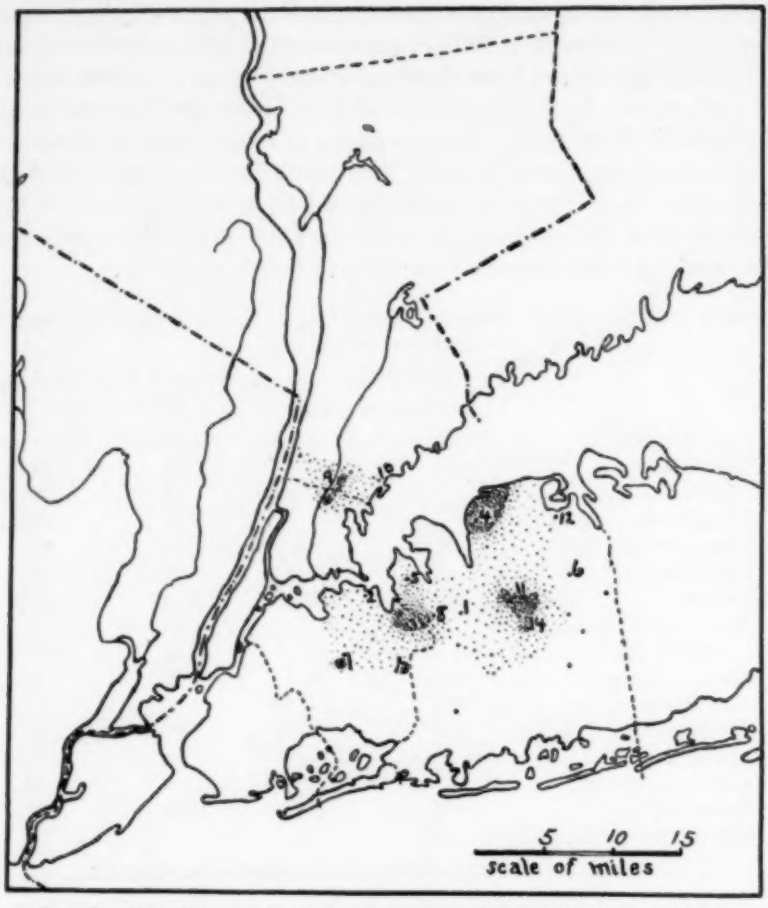


FIG. 8.—Distributon of *Aserica castanea* in New York State in 1928.

months at a heavily infested locality about one mile north of the Westbury railroad station, and 188,250 adults were captured. The beetles were more active when it was warm, and 21,000 were captured in this trap during one night when the temperature did not fall below 72°F.

A number of diggings one foot square and eight inches deep were made in a field which joined the garden where the trap light was located.

The population in this field was found to range from 100 to 157 grubs to the square foot. In the village of Westbury, lawns were observed in which there were approximately 150 grubs to a square foot. Although the accompanying table shows that in Douglaston it was not possible to find a lawn where more than 45 grubs to the square foot could be found, the adult beetles damaged plants considerably more than at any other locality in New York. This district of severe injury extended over Douglaston, Little Neck, and Lakeville, and some injury to foliage was apparent as far north as Great Neck. The injury to foliage around Glen Cove was about equal to that in the vicinity of the trap light, but the density of grub population was less than in the latter.

Infestations of the oriental garden beetle, like those of the Asiatic beetle, tend to be uneven in density of grub population, but they are not confined to well kept lawns. The grubs have frequently been found in sod lands which were covered with tall, unmowed grass. The averages given in the table were derived from data obtained while making diggings both in well kept lawns and in fields where the grass was mowed only once during the season.

The Imported Serica

The imported Serica, *Serica similis*, has been observed on Long Island in Nassau and Queens Counties around Westbury, Douglaston, and Flushing. In 1927, forty-four adults were taken at a light on the estate of Howard Phipps, which is located about one-quarter of a mile north of Westbury. During 1928 the adults were found flying during warm evenings from June 5 until July 25, but only 121 were taken during the season in this vicinity.

President W. B. Herms: The next paper will be by E. A. Richmond and F. W. Metzger.

A TRAP FOR THE JAPANESE BEETLE[1]

By E. Avery Richmond, *Agent*, and F. W. Metzger, *Assistant Entomologist*, *Research Laboratory, Bureau of Entomology, Moorestown, N. J.*

Contribution No. 36

Abstract

Four years' experience relative to the evolution of a trap for the Japanese beetle, *Popillia japonica*, is given. The so-called standard trap has been decided upon as the most satisfactory to date. The traps tested are briefly described and figured, and the composition of the attractive bait is given. The proportion of the sexes

[1] *Popillia japonica* Newman.

caught and the comparative abundance of beetles collected in different localities during the same year as well as over a period of two years are discussed. Temperature and humidity had an important bearing on the beetle collections. The efficiency of the standard trap is considered, and modifications which improve its catch are described. Although the trap is practically specific for the adult Japanese beetle, other species which were caught are mentioned. The use of traps as a possible protection for orchards and their value in investigating the abundance of beetles are dealt with.

Intrdouction

A method for the destruction of Japanese beetles was desired, and the use of a trap, in which one of the attractive baits that had been devised by the Physiological Section of the Japanese Beetle Laboratory could be utilized, seemed to be a promising solution.

The first trap, used in 1924, is shown in Plate 11, Fig. 1. This trap was cumbersome, and difficult to manipulate. The second, or jar trap, is shown in Plate 11, Fig. 2. The principal disadvantages in this type were that the beetles got into the bait, and that rain collected in the jars.

Description of the Standard Bait Trap

The standard bait trap (Plate 13, Fig. 1) was devised in the winter of 1924–25. It is 12 inches high and 7 inches in diameter and is made of galvanized iron. The lower end is entirely closed, except for a very small hole to permit the escape of liquids or gases. A narrow flange, upon which the bottom of the bait container rests, extends around the inside of the cylinder 5 inches from the bottom.

The rim of a funnel fits snugly over the upper edge of the cylinder. The funnel is 7½ inches long and the lower end reaches just below the bottom of the bait container. The circular opening of the stem of the funnel is three-fourths of an inch in diameter. The diameter of the bait container is slightly less than that of the trap cylinder so that it can be easily removed. It is 1⅞ inches high, and the bottom is covered with 16-mesh copper screening. In its center there is an opening 1½ inches in diameter, which admits the lower end of the funnel.

It is advisable to have the exterior of this trap with as few projections as possible. Where the bottom extends beyond the body of the trap and the edge of the funnel does not cover the cylinder properly the attracted beetles may alight on such places, and thus will not enter the trap directly. (Plate 12, fig. 2).

Other Types of Traps

Other traps were tested, but they did not approach the standard bait trap in efficiency. The standard trap was furnished with a removable bottom, but this proved unnecessary and awkward to handle.

Different sizes and arrangements of funnels were tested in connection with both the standard and the jar traps. The results, as seen from Table 1, indicate that the use of a series of superimposed funnels instead of the usual single funnel materially increased the catch in 1925. These results were corroborated by further tests in 1927, when a standard trap with a tier of four funnels caught 4,572 beetles in a period of ten days, in contrast to a standard trap with the usual single funnel, which caught only 2,797. Funnels with canvas attached to their rims or with perforations did not increase the catches.

Table 1. Number of Beetles Caught in Traps with Different Funnels
(All traps were placed in the same cherry tree and hung at the same height.)

Type of Trap	Type of Funnel	Aug. 10	Aug. 12	Aug. 14	Aug. 15	Total
Jar trap	Single (4.25″)	49	56	85	119	309
Jar trap	4-tier (4.25″)	382	59	91	33	565
Jar trap	Single (5.50″)	52	68	178	142	440
Jar trap	Single (6.25″)	59	103	238	137	537
Standard trap	Single (7.00″)	554	—	75	193	822
Standard trap	4-tier (7.00″)	1741	—	461	474	2676

Holes in the sides of a trap to permit the odor of the bait to escape did not give better results. The drain hole in the bottom and the mouth of the funnel are apparently sufficient.

The "weather-bureau" trap was devised in an attempt to make a larger trap. The distance from the upper edges to the inside of the trap was so great that a beetle, after hitting it, would recover its equilibrium and fly away without falling in. A modification of this trap (Plate 13, Fig. 1), tried in 1926, was not as satisfactory as the standard trap.

Baits

Each kilogram of the standard bait contains 500 grams of bran, 455 grams (350 c.c.) of molasses (refiners' sirup 75%), 44 grams (40 c.c.) of glycerine, and a quantity of an attrahent. With geraniol as the attrahent making up at least 5 per cent of the prepared bait, the bran-glycerine-molasses mixture does not deteriorate to any marked degree when not exposed to the weather. Its attractive odor has been retained more than three years in some traps. When only 2.5 per cent of geraniol is used, however, it will not prevent the baits from becoming mouldy in

the field, and a preservative must be used. Citral, phellandrene, safrol, and linalool of 2.5 per cent, and sassafras (natural) of 5 per cent concentration will preserve the bait. In practice, baits are renewed twice a month, 150 grams of the prepared bait being used in each trap.

The addition of a small quantity of eugenol materially increased the attractiveness of a geraniol bait, and permitted a reduction in the quantity of geraniol. The purer grades of geraniol are apparently better

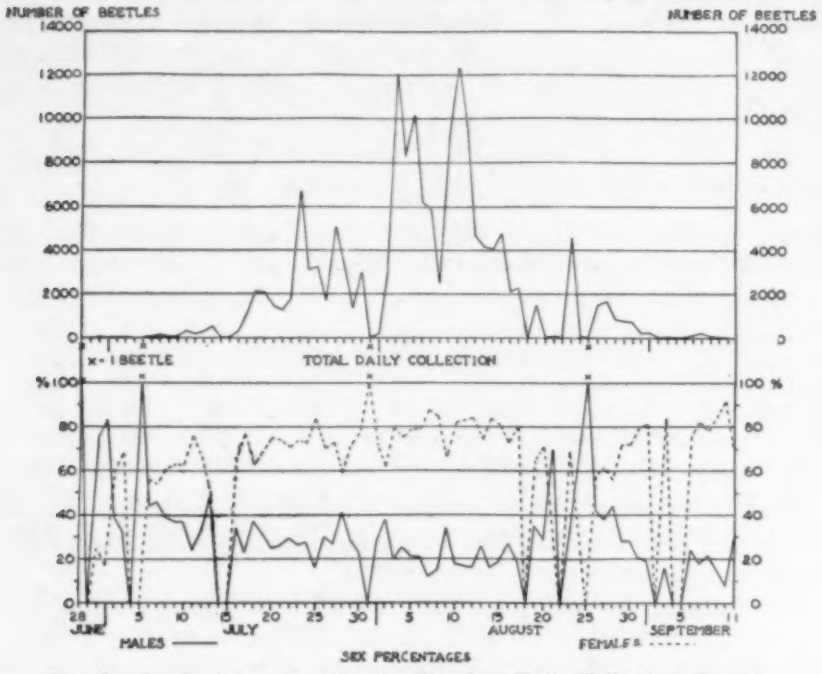


FIG. 9.—Sex Percentages of Beetles Based on Daily Collections from a Single Bait Trap, June 28–Sept. 11, 1926

than lower grades. The best bait attrahent, however, was found to be a technical geraniol, 58.8 per cent pure, used in the proportion of 2.5 per cent, together with eugenol in the proportion of 0.25 per cent of the total material. This is still the standard bait.

PROPORTION OF THE SEXES CAUGHT

Considerable data relative to the proportion of sexes present during certain periods of time were obtained from the trap collections. There was generally an excess of females throughout the season, regardless of the attrahent used. Collections in 1925 from two standard traps

showed that during the early part of the season nearly as many males as females were captured, but as the season progressed the proportion of females materially increased. The ratio during the morning was similar to that during the afternoon. The greatest weekly ratio, 1 male to 3.22 females, was recorded during the week beginning August 2, and the ratio for the entire season approximated 1 male to 2.5 females.

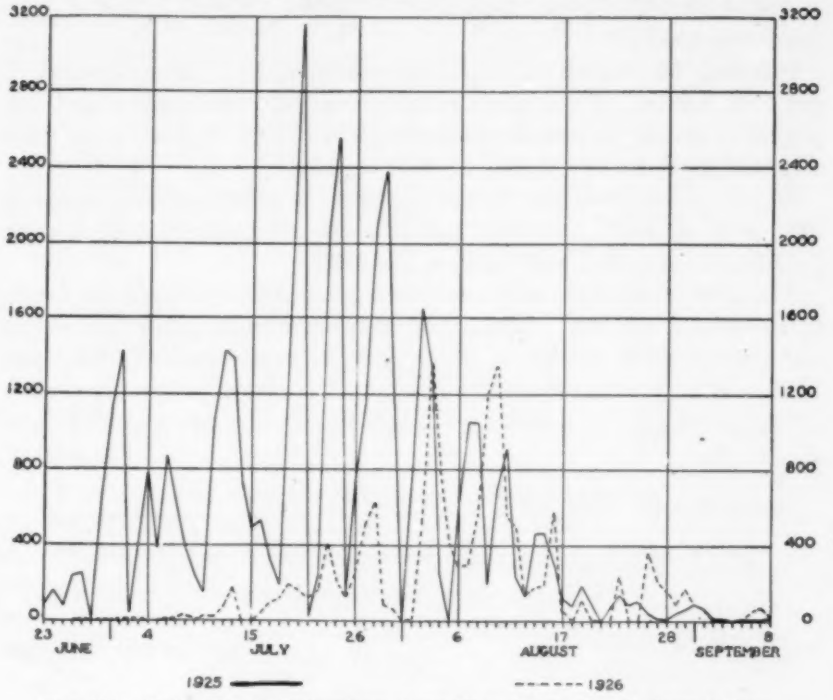


FIG. 10.—Daily Beetle Collections, June 23 to September 8, from a Trap Baited with Geraniol Located at the Same Point for Two Years

Fig. 9 shows graphically the sex percentages based on daily collections from a standard bait trap during 1926. A ratio for the season of 1 male to 3.14 females was obtained with this trap. On August 7 the ratio was 1 male to 7.15 females.

No extensive examinations have been made to determine whether the trapped females were gravid or spent, but dissections of a few individuals warrant the statement that some, at least, contained eggs.

COMPARATIVE ABUNDANCE OF BEETLES

The total collections from two traps, located in different orchards, exceeded 80,000 beetles during the season of 1925. At the height of

the season there were as many as 20 traps in the field at once, but at other times there were only a few. The total number of beetles collected was nearly 300,000. This number gives some idea of the value of traps.

In 1926, a bait trap was located in the center of each of six orchards from June 23 to September 11, while another was placed in an orchard from June 28 to September 11. Plate 12, Fig. 2, shows one of these traps in operation. The greatest number of beetles trapped in any one orchard was 155,018.

One trap was baited with geraniol absolute (88.8 per cent pure) 10 per cent, instead of the usual geraniol-eugenol combination, and was placed in the same tree in 1925 and 1926. Fig. 10 shows the daily collections for the two years.

It will be seen that the beetles appeared in great numbers earlier in 1925 than in 1926, and that the greatest collection in 1925 was on July 20, as compared with August 3 in 1926.

The total number of beetles collected in bait traps during 1926 closely approached 2,000,000. The largest number of traps in the field at any one time in 1926 was 39, of which only 32 were standard bait traps. The other 7 were experimental forms, which captured only a few beetles. The greatest number taken by a single trap in one day was 13,476, on August 3.

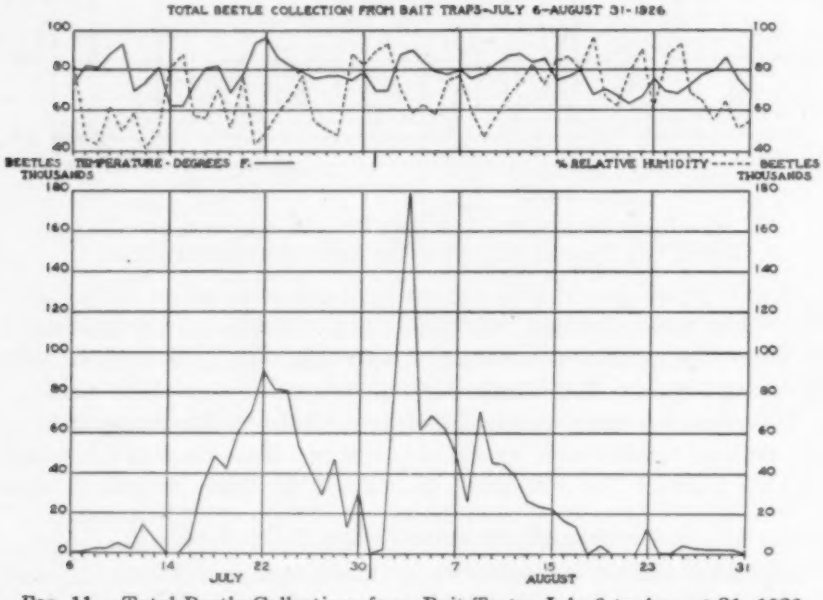


FIG. 11.—Total Beetle Collections from Bait Traps, July 6 to August 31, 1926

Fig. 11 gives a daily record of the total collections from all bait traps located in the field from July 6 to August 31, 1926, inclusive.

Efficiency of the Standard Bait Trap

As it was obvious that all the beetles attracted to the traps were not caught, the efficiency of the standard trap was tested. The number attracted to certain traps and the number caught were counted; the results are shown in Table 2. A beetle was considered attracted when it approached the trap in such a manner as to indicate clearly that it was influenced by the odor.

Table 2. Number of Beetles Attracted Compared to Number Caught

	Attracted	Caught	Per cent Caught
	31	4	12.9
	162	43	26.5
	45	9	20.0
	34	19	55.9
	35	7	20.0
	485	125	25.8
	569	172	30.2
	130	56	43.1
	915	293	32.0
Total	2406	728	30.3

The observations, each of which covered one day's catch, were made on four different days, and five different traps were used. The average proportion of beetles caught was 30.3 per cent.

Many beetles leave the trap after having been attracted, but soon return, and are finally captured, or leave the vicinity of the trap, and many individuals were probably counted more than once. The percentage of beetles caught may therefore be higher than the figures indicate.

How the Beetles Are Caught

The beetles are apparently greatly excited by the aroma of the geraniol-eugenol combination. They strike the funnel, lose their equilibrium, and are precipitated into the trap. Table 3 gives data on the manner of their falling into the trap.

Table 3. How Beetles Entered the Trap

Trap No.	Hit Funnel and Fell In	Lighted on Funnel Then Fell In	Fell in From Foliage Above	Total Number Caught
1	7	2	0	9
2	16	1	2	19
3	7	0	0	7
4	170	0	2	172
5	56	0	0	56
Total	256	3	4	263
Per cent	97.3	1.2	1.5	

Experiments to Increase the Efficiency of the Standard Bait Trap

Since many of the beetles which were attracted to the trap did not appear to be able to locate the source of the odor accurately enough to find their way into the funnel, three other modifications in the trap were tried.

(1) A Large Tub Filled With Water Placed Under the Trap. Two large galvanized iron wash tubs were filled with water and placed on platforms supported by posts, under traps suspended from apple trees, so that the surface of the water was three inches below the trap. (Plate 12, Fig. 3).

Table 4. Number of Beetles Collected From July 2 to August 19, 1926 by Means of Standard Bait Traps Placed Over Tubs of Water

Trap No.	Beetles in Water	Beetles in Trap	Total
4	37,604	32,073	69,677
25	32,677	39,047	71,724
Total	70,281	71,120	141,401
Per cent	49.7	50.3	

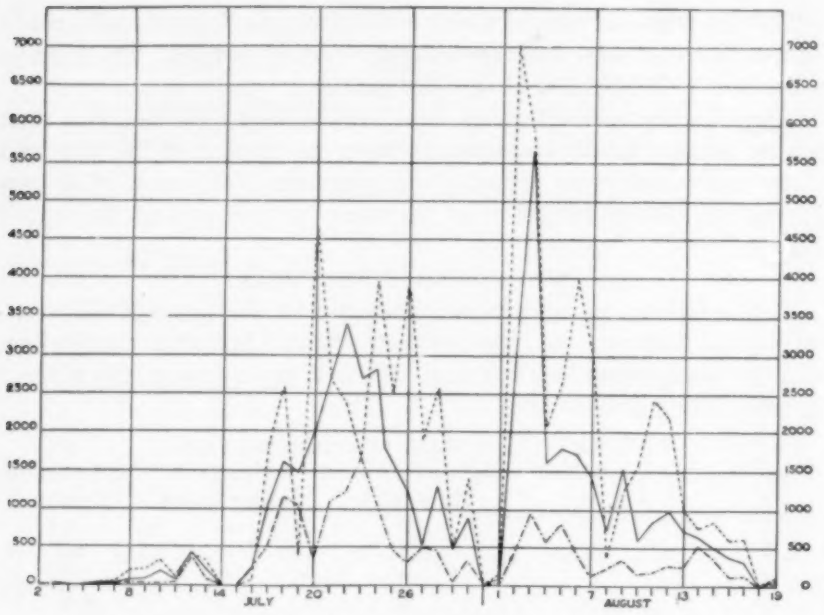


Fig. 12.—Daily Beetle Collection from Three Types of Traps, July 2 to August 19, 1926

Nearly as many beetles were collected from the water as from the traps, as shown in Table 4. Fig. 12 gives a comparison of the catch of these traps with that of traps without water.

Explanation. - - - - - - - - -, standard bait trap over tub.

————————, standard bait trap.

— — — — — —, pail over kettle.

The daily collection, in almost every instance, was increased by the addition of the tub of water. No beetles were observed to escape from the water. The tub of water increases the effectiveness of the trap, but it is cumbersome; it has to be refilled from time to time, and the beetles have to be removed from the water, which requires a little more labor.

(2) A Sheet Metal Baffle Suspended Above the Trap Funnel. A piece of sheet tin, 4 3/8 by 4 3/4 inches, was attached to the supporting wires of a trap to stop the beetles which ordinarily pass over the top. In a 5-hour period, from 11:00 a. m. to 4:00 p. m., 1,112 beetles were caught in such a trap, whereas 1,005 were caught by the check trap, an increase of 107 beetles, or 10.6 per cent. During a 3-hour period, 203 beetles entered the trap directly, 182 were caught by striking the baffle and falling in, and 190 were lost by glancing off of the baffle.

(3) The Trap Painted Green. A total of 53,711 beetles were collected from June 29 to August 25, 1926, from a trap painted green to blend with the color of foliage, while 50,163 were collected from an unpainted check, a difference of 7.1 per cent. In 1927 three green traps were tested in comparison with three unpainted traps. An average of 50,689 beetles per trap were caught in the green traps, as contrasted with an average of 37,666 in the unpainted traps, or a difference of 34.6 per cent.

New Traps Tested in 1926

(1) Pail Over Kettle. A small, covered tin pail with several holes in its sides was filled with 150 grams of bait, and suspended a few inches above an ordinary kettle filled with water. The average collection per trap from two of these was 17,009 beetles for the entire period, while that from twenty standard bait traps in the same orchard was 48,053 per trap.

(2) Bait Can Over Tub. This trap consisted of a large galvanized iron tub filled with water, over which four perforated bait cans were suspended. The results from this type of trap were unsatisfactory.

(3) Evaporation Cups. Four evaporation cups[2] were each filled with

[2]Peterson, Alvah. An evaporation cup useful for chemotropic studies of insects in the field. Jour. Econ. Ent., 19 (6): 863–866, illus. 1926.

2.5 c.c. of geraniol (83% pure) and floated in a pail of water. Very few beetles were caught in the water, and this type of trap was discarded.

The Use of Traps as a Protection for Orchards

Twenty-five traps, placed on trees around the sides of an apple orchard in 1926, failed to protect the trees, although over a million beetles were taken during the period from July 29 to August 19. Apparently the beetles attracted were too numerous to be taken care of by such a small number of traps.

It was decided to test the value of traps placed a short distance from the orchard. In this way it was anticipated that the beetles upon approaching the orchard would be trapped, and the beetles within the orchard would be drawn out.

The traps were hung on posts, 5 feet apart, in a row parallel to the south side of the orchard. A strip of cheese cloth 1 foot wide was stretched from post to post just above the traps and, on favorable days, was sprayed with a weak geraniol emulsion. A tub of water was set between every fourth and fifth post (Plate 13, Fig. 2), and enough geraniol emulsion was placed in each tub to form a film over the water.

As the beetle season was waning it proved impossible to give this experiment a fair test in 1926, but it was repeated in 1927 with slight modifications. It proved unsuccessful, although it still seems possible that an orchard might be protected by the method if a sufficient number of traps, with the right concentration of geraniol and eugenol, were placed at the proper distance from the orchard.

The Value of Traps for Investigation of the Japanese Beetle

In addition to their usefulness in capturing Japanese beetles, traps were used extensively in connection with ecological investigations. Traps were placed at various points throughout the infested area to obtain data on the relative abundance of the beetle in different localities. The information thus obtained corresponded very closely with conclusions based upon supplementary personal observations. Traps have also been employed to obtain data on the degree of infestation at certain definite points in different years (Fig. 10). The results show that smaller trap collections than those of the previous year are correlated with less beetle injury in the vicinity. It is interesting to note that beetles are caught by the traps before any are observed in the immediate neighborhood. The first beetle trapped in 1926 was taken on

1. Globe trap

2. Jar trap

1. Standard bait trap unassembled: A, Bait container; B, Trap cylinder; C, Funnel

2. Standard bait trap in operation

3. Standard bait trap over tub filled with water

1. "Weather Bureau" trap (1926)

2. A line of traps outside an orchard (1926)

June 27, but it was not until two days later that beetles were observed in the orchard where the trap was located.

A further use to which the traps have been put is that of obtaining indications of the numerical ratio of the sexes throughout the summer (Fig. 9).

A comparison of the collections with climatological conditions has been made (Fig. 11). In general, a high temperature and low humidity are favorable for trap collections.

Cost of Operating a Standard Bait Trap[3]

Traps manufactured according to our specifications vary in price from $1.50 to $3.50. The cost of materials for one baiting is about four cents.

Other Insects Caught by the Standard Bait Trap

The attractive agents, geraniol and eugenol, now used in these traps are almost specific for the Japanese beetle, although a number of other insects have been taken in the traps. In some cases only a few individuals of a given species have been taken, indicating that their capture was accidental, while other species have been trapped in fairly large numbers.

Seventeen specimens of *Ophistomis luteicornis* Fab. were found between June 24 and July 6, 1925, in traps baited with absolute geraniol (88.8 per cent pure) 10 per cent. Fifteen *Typocerus velutinus* Oliv. were taken between June 25 and July 26 of the same year from traps baited with the same material. The two examples just cited were the two highest collections of insects other than the Japanese beetle during 1925. In 1926 over 200 individuals of *Chauliognathus marginatus* Fab. were captured by two traps baited with technical geraniol (58.8 per cent pure) 2.5 per cent and eugenol 0.25 per cent. One of the traps was located in a plum orchard and the other in a peach orchard. Most of these beetles were taken between June 23 and July 1. Six beetles of this species were collected in 1925 from traps baited with absolute geraniol (88.8 per cent pure) 10 per cent.

In spite of the fact that very few species are found in the standard trap, the construction of the trap is such that it could doubtless be used to advantage for capturing insects other than the Japanese beetle, provided attractive agents for such insects be found.

[3]For a more extended treatment of this phase of the subject see Metzger, F. W., Information Concerning Japanese Beetle Traps, State of New Jersey Dept. of Agri. Bureau of Statistics and Inspection. Circ. 146, pp. 8, illus. May 1928.

SUMMARY

The standard bait trap as described in this paper catches at least 30 per cent of the beetles that are attracted to it by the bait. The most satisfactory bait which has been found is a mixture of bran, refiners' sirup, glycerine, geraniol, and eugenol. Attracted by the bait, the beetles fly to the trap, and most of those caught strike the funnel and are precipitated into the container before they can take wing again.

Several modifications of the standard trap have been tried. A tier of four funnels was found to catch more beetles than the single funnel. A receptacle containing water placed under a trap almost doubled its efficiency. A tin baffle suspended over the mouth of the funnel increased the catch by about 10.6 per cent. Painting the trap green also increased its efficiency. Other types of traps proved unsatisfactory.

Nearly three times as many females as males are captured by the traps, and the traps appear to be effective indicators of beetle abundance in any locality.

Bait traps suspended from all the trees in the outside rows of an orchard did not prevent beetle injury, but it is believed that an orchard might be protected if it were surrounded by a sufficient number of traps placed at the right distance from the orchard, with bait of the proper concentration.

The standard bait used is of value chiefly for the Japanese beetle, although other species of insects have been caught.

MR. N. E. MCINDOO: I understand that there have been one or more beetle traps invented, patented, and placed on the market. In fact, I want to ask what type has been placed on the market and which is the best type?

MR. E. A. RICHMOND: I feel, of course, that the best type on the market is that which we ourselves have recommended. It is only natural that we have gone farther in developing the proper trap since we have had a head-start of several years on the manufacturer. A certain manufacturer interviewed us, and after borrowing our ideas for improvements, even went so far as to patent such ideas.

The trap, which I mentioned as the so-called standard trap, is doubtless the most practical form at the present time. All of the traps on the market conform to the same general principle although they vary somewhat in detail. The trap, which we are recommending, has actually been tried out in the field whereas many of the other traps on the market have been made up in anticipation that they would work. I mention this fact because in our experimentation there were several models of traps, the "weather bureau" trap for instance, which appeared to be satisfactory, but failed on account of certain minor details.

The standard trap gave a very excellent catch. Tests showed that at least thirty per cent of the beetles attracted to the trap were caught. Baffles increased this percentage about eleven per cent; painting the trap green about six per cent, while the use of superimposed funnels gave a material increase. Many beetles not caught the first time no doubt return. I really believe that at least sixty per cent of the beetles coming to the trap are caught. The use of a receptacle of water beneath the trap nearly doubled its efficiency.

MR. C. L. MARLATT: I would like to ask how far they go?

MR. E. A. RICHMOND: No definite tests to determine the distance beetles travel to trap baits have been conducted. Attractive sprays, however, give some idea of the situation, although the odors of sprays spread over a greater area than when bound up in bran baits. Geraniol, used at the rate of one to a thousand in an arsenate of lead spray, attracted beetles from an orchard at least half a mile away. They could be seen streaming across the fields in the direction of the attractive odor.

MR. L. O. HOWARD: What other insects are attracted?

MR. E. A. RICHMOND: There are very few insects other than the Japanese beetle attracted to the traps. The bait is practically specific for the Japanese beetle. *Ophistomis luteicornis* Fab., *Typocerus velutinus* Oliv., and *Chauliognathus marginatus* Fab., have been captured infrequently early in the season, but when the Japanese beetles are present in great numbers, practically nothing else is taken.

MR. C. L. MARLATT: Very thorough and intensive annual surveys are made over regions beyond the old quarantine lines, state-wide or more, to determine the spread of the beetle. Frequently these surveys as in Maryland and Pennsylvania take into consideration practically every town and village. This year we are hoping to increase the value of these surveys by the use of beetle collecting traps. Such trapping will have the advantage of working more or less throughout the season instead of being limited to a few hours or a few days of active inspection work for each point. Necessarily, provision will have to be made for the periodic inspection of such traps.

In connection with certain isolated points of invasion which have been determined during the past two seasons we hope to get very material aid in an effort to control and perhaps at some of these points to eradicate the beetle through the agency of the distribution of large numbers of these traps. These will be baited with geraniol, a substance which is apparently very attractive to the beetles, and it is possible

that where the beetle has very slight foothold, if any, the findings being only from one to a very few beetles in a town, eradication may result.

The Control Administration is planning on using a large number of traps in a clean-up program of isolated infested areas as well as at the outer borders of the infested area. What are your ideas of such a procedure?

MR. E. A. RICHMOND: We have hopes that the use of traps on a large scale will prove feasible. As yet we have not given this phase of the subject a thorough test, but I believe that the preliminary results warrant further work along such lines.

MR. C. L. MARLATT: How long does the bait last without care?

MR. E. A. RICHMOND: Baits will last, provided that the weather conditions are right, practically the whole season, although in our tests we replaced them at intervals of two weeks in order to keep the odor at a fairly constant level. During specially rainy weather the bait at our recommended concentrations sometimes becomes moldy, and upon drying out cakes up so that it is useless. An increase from a 2.5 per cent to a 5.0 per cent concentration of geraniol overcomes such difficulty, evidently sterilizing the bait.

I take the liberty at this time to mention a paper entitled "Information Concerning Japanese Beetle Traps" prepared by my associate, Mr. F. W. Metzger, and issued as Circular No. 146 of the State of New Jersey Department of Agriculture. This circular gives information relative to the practical use of the traps. What I have given you relates primarily to the experiments we have conducted.

SECRETARY C. W. COLLINS: I should like to ask Mr. Richmond if he has any data on the cost of a trap in operation.

MR. E. A. RICHMOND: Information relative to the cost of traps is given in Circular No. 146, which I just mentioned. The cost of the trap, of course, depends primarily upon the manufacturer and in what quantities he makes them. Traps manufactured according to our specifications vary in price from $1.50 to $3.50. The cost of the bait is practically negligible since it amounts to only about four cents per trap. The exact cost of each ingredient is given in Circular No. 146. When traps are manufactured in large numbers, I believe they will get down to perhaps fifty cents or less, but that is hard to tell. I warn the public against buying traps constructed of too shoddy material, for then many difficulties are apt to be encountered.

MR. E. P. FELT: May I inquire what the function of the cheese cloth was in connection with that line of traps next to the orchard?

MR. E. A. RICHMOND: We simply used it to see if it would increase the odor in that particular locality and thus attract more beetles.

MR. E. P. FELT: Is there no connection between the cheese cloth and the traps?

MR. E. A. RICHMOND: No, sir. However, it offered a resting place in the vicinity of the traps for those beetles which were not immediately caught by the trap. It also gave an additional check on the number of beetles coming in.

MR. G. W. HERRICK: Was the cheese cloth sprayed with geraniol?

MR. E. A. RICHMOND: A 0.4 per cent geraniol emulsion was used.

MR. E. P. FELT: I would like to ask one thing more. Have you experimented with the possible efficiency of a smooth wall, we will say, like your cheese cloth, against which the insects could fall and then slide into some kind of a trap? I will add for the sake of explanation that such a device on a building in Albany provided a most effective insect trap. Possibly it might be worked out in connection with Japanese beetles.

MR. E. A. RICHMOND: Nothing exactly like such a device has been tested, but the whole principle of catching the beetle is really that of hitting a barrier, such as the baffle or the funnel itself, and sliding into the trap.

MR. E. P. FELT: Wouldn't you get a great deal larger catching area with a plain surface?

MR. E. A. RICHMOND: Yes, that is very true, but it must be remembered that if the drop is too great the beetle will regain its equipoise and fly away. Such was the case with the "weather bureau" trap.

MR. E. P. FELT: There is just one other factor I would like to mention. Not only would a vertical section like that which is smooth catch the insect, but if you had at the base a metal trough or something which would heat up, it would kill them. The heat of the sun on the metal surface would kill them.

MR. L. O. HOWARD: What proportion of the beetles caught were females?

MR. E. A. RICHMOND: The proportion of males to females varied somewhat during the season. In the earlier part of the season nearly as

many males as females were taken, but the ratio for an entire season approximated one male to every three females.

MR. L. O. HOWARD: Were the captured females fertile?

MR. E. A. RICHMOND: Dissection showed that some of the females at least contained eggs, but I have made no tests relative to their fertility. However, I see no reason why they should not be fertile.

MR. H. G. BUTLER: Have you made any tests with Tanglefoot?

MR. E. A. RICHMOND: Tests have been made with Tanglefoot, but it doesn't seem to hold the beetles.

PRESIDENT W. B. HERMS: The next paper will be by W. E. Fleming.

THE HOT-WATER TREATMENT OF NURSERY PLANTS[1]

By WALTER E. FLEMING, *Entomologist*, and FRANCIS E. BAKER, *Assistant Entomologist, United States Department of Agriculture*

ABSTRACT

The hot-water treatment to destroy the immature stages of the Japanese beetle, *Popillia japonica*, was applied to 164,000 nursery plants of 59 species during the dormant season of 1927–1928. Twenty-six species were treated successfully. The treatment retarded slightly the development of 3 species and more or less severely injured 30 species. The cause of the failure of the treatment of many varieties in the nursery is not as yet definitely established.

The treatment of nursery plants by submerging the roots in hot water at 112°F. has been shown to be one of the most effective and simple methods for destroying infestation by immature stages of the Japanese beetle, *Popillia japonica* Newman. The dependability of the hot-water treatment as a quarantine measure for preventing the artificial dissemination of this insect in soil about the roots of nursery plants has been demonstrated by the results obtained during the last two years in experiments involving over 1,000,000 eggs, larvae, and pupae. A preliminary report covering the first year of the insecticidal phase of the investigation was published recently in the JOURNAL OF ECONOMIC ENTOMOLOGY.[2]

The hot-water treatment, however, could not be recommended, even tentatively, for the treatment of valuable nursery plants until data had

[1]Contribution No. 53 of the Japanese Beetle Laboratory, Moorestown, New Jersey.

[2]Fleming, W. E., and Baker, F. E. Hot water as an insecticide for the Japanese beetle in the roots of nursery stock. Jour. Econ. Ent. 21:818–822. 1928.

been obtained on subsequent effects of the treatment on the several hundred varieties which are grown commercially within the quarantined area.

Preliminary Experiments

Through the cooperation of interested nurserymen, 1,500 plants, of 87 varieties, were selected for experimentation. These plants were treated while dormant during the winter of 1926–1927, and were placed in greenhouses for observation. Five months after the application of the treatment, the condition of the plants indicated that 64 of the varieties had not been injured by the hot water and that 23 of them had been killed or greatly retarded in their development. In view of the successful treatment of the majority of the plants in this preliminary experiment, the writers were encouraged to proceed with experimentation on a relatively large scale at the commercial nurseries.

Treatment in Commercial Nurseries

During the dormant season of 1927–1928, 164,000 nursery plants of 59 species were treated with hot water. The treatment, so far as possible, was made an extra step in the usual nursery procedure of preparing the different varieties for market. The plants were prepared for treatment by removing the loose soil, dividing the large clumps of roots, and pruning the tops and roots. *Iris* spp., *Phlox* spp., *Dahlia* spp., and other small plants were packed loosely in wire baskets or other suitable containers which would permit the free circulation of water. *Berberis* sp., *Spiraea* spp., *Lonicera* spp., and other shrubs were placed individually in the treating tank. Small plants were completely submerged in the water since it was practically impossible to treat only the subterranean portions of these varieties. The larger plants were placed in the hot water in such a manner that only their roots were submerged. The plants were heated until the temperature of the submerged parts was 112°F. and then held at this temperature for a period of 70 minutes.

Each variety was handled after treatment according to the usual commercial practice of the nursery. No attempt was made to handle the treated plants more carefully than the untreated stock, as it was maintained by the nurserymen that the treatment, to be practical, had to be successful under ordinary commercial conditions, without the exercise of special care for the plants. Some varieties were packed within a few hours in sphagnum moss and placed in cold storage; other varieties were potted and set in greenhouses or cold frames; other

varieties were planted outside in soil free of infestation. The treated plants were kept under close observation and were compared frequently with untreated plants of the same species under the same condition throughout the season.

Results of Commercial Treatment

The condition of these 59 species of plants in the commercial nursery at the end of the season was as follows: Twenty-six species had been treated successfully; 3 species had been retarded only slightly in their development; and 30 species had been more or less severely injured by the treatment. The results indicate that the treatment was applied successfully on *Allium schoenoprasum*, *Amsonia salicifolia*, *Astilbe* sp., *Baptisia australis*, *Dahlia* spp., *Funkia lanceolata*, *Hemerocallis dumortieri*, *H. fulva*, *Iris cristata*, *I. germanica*, *I. japonica*, *I. ochroleuca*, *I. pseudacorus*, *I. sibirica*, *Liatris pycnostachya*, *Lythrum salicaria*, *Paeonia* spp., *Phlox* spp., *Polygonum compactum*, *Spiraea palmata*, *S. ulmaria*, *Statice latifolia*, *Thalictrum glaucum*, *Tradescantia virginiana*, *T. alba*, and *Vaccinium* spp. The treatment retarded slightly the development of *Pentstemon digitalis*, *Phalaris arundinacea*, and *Sedum spectabile*. It killed, or severely injured, half of the plants of *Achillea ptarmica*, *Arrhenatherum bulbosum*, *Eupatorium ageratoides*, *Hydrangea arborescens*, *H. opuloides*, *Rudbeckia laciniata*, *R. subtomentosa*, *Silphium perfoliatum*, *Solidago altissima*, *S. canadensis*, and *S. shorti*. It killed, or severely injured, three-fourths of the plants of *Aster novae-angliae*, *Veronica amethystina*, *V. incana*, *V. repens*, and *V. spicata*. The treatment was a failure under commercial conditions on *Aquilegia chrysantha*, *A. flabellatia*, *A. vulgaris*, *Berberis thunbergi*, *Calimeris incisa*, *Chelone lyoni*, *C. glabra*, *Echinops ritro*, *Eryngium maritimum*, *Festuca glauca*, *Gypsophila repens*, *Lonicera japonica*, *Poterium obtusum*, and *Stachys grandiflora*.

Discussion of Results

Many of the species of plants which were injured under commercial conditions have been treated successfully under experimental conditions. Consequently, it is probable that many of these varieties could be treated successfully if the methods of handling in the nursery were changed.

The cause of the failure of the treatment on many varieties is not as yet definitely established. There are, however, many factors which influence the susceptibility of plants to hot water, such as treating before the plants are in the proper stage of dormancy, treating before

plants are properly cured, improper cooling and drying after treatment, and improper storage.

There is still considerable experimental work to be done before the proper method of handling the plants in the commercial nurseries can be definitely determined. The results obtained to date indicate, however, that the hot-water treatment can be applied successfully to many varieties under the present nursery methods of handling them, and that it may be applied successfully to many more varieties after the nursery procedure has been modified.

PRESIDENT W. B. HERMS: The next paper will be by V. I. Safro.

SOME OBSERVATIONS ON JAPANESE BEETLE INJURY

Part I—Unsprayed Communities

By V. I. SAFRO, *Trenton, New Jersey*

ABSTRACT

Several factors affect the occurrence and degree of injury by *Popillia japonica* to shade trees in unsprayed communities. Exposure to sunlight, rapidity of growth and proximity to favorite breeding grounds favor attacks. A shady environment is very much of a repellent factor.

The observations herein reported are intended to help clarify the problem of normal expectation of Japanese beetle injury to shade trees in unsprayed communities, in order that spraying programs may be adequately inclusive.

Economic Entomology endeavors to record insect habits as a basis on which control or defensive procedures may be developed. Observations are usually made under what are generally understood to be normal conditions, but it also becomes advisable to record habits that occur under actual conditions as contrasted with so called normal conditions.

The spraying of shade trees for protection from Japanese beetles is done before the insects appear in numbers, and before any appreciable injury is apparent on the trees. An endeavor to plan a spraying program at this time therefore frequently leads to controversy among local authorities as regards the trees that are subject to beetle injury. Investigations, conducted over a number of years, have indicated the normal preferences of the Japanese beetle for certain plants. In a general way, we know what shade trees the Japanese beetle will attack first in unsprayed communities, and what it will attack most severely. However, there are many apparent exceptions to such preferences. While normally, in a community which is already within the heavily infested zone, a

good guide for the purpose may be the previous occurrences of injury, this does not always hold true, especially in years of comparatively lighter infestations. Furthermore, it does not hold true in districts that have not previously been included in the zone of heavy infestation. The exceptions indicated do not detract from the value of the basic observations, and an understanding of them will help to explain the deviations and to harmonize the differing observations on the food preferences of this insect.

It is not always possible or practical to conduct community spraying in close accordance with technical results and official recommendations. Technically, many trees should be omitted from any spraying procedure, yet it may be found advisable to permit such trees to be treated when their omission would be conducive to confusion in the minds of the operating crews. Similarly, when the funds or the time available for the work are limited, it may be necessary to exclude certain trees that are susceptible to Japanese beetle injury. Hence it is important to know what trees of the susceptible species can best be omitted. In other words, wherever it may be necessary to limit the community spraying work, the logical plan should permit of such limitation with maximum efficiency and minimum beetle injury to the unsprayed trees.

It is known that practically all coniferous trees are immune to Japanese beetle attack, with the possible exception of larch and bald cypress. Of the deciduous trees, such species as sweetgum, magnolia, tulip tree, most of the maples, common locust, and catalpa are also among the practically immune species—though incidental feeding may take place. Such trees can be omitted from the spraying program, except where other chewing insects are concerned, and except where their inclusion is justified for purposes of smooth operation.

The linden (basswood), horse-chestnut, and elm are considered most susceptible to injury. Following them are willow, Lombardy poplar, and European white birch, listed in the order of normal decreasing susceptibility. In the group termed "occasionally attacked" are planetree (buttonwood, sycamore), Norway maple, pin oak, and chestnut oak, also in the order of decreasing susceptibility. Apparently trees most subject to attack can be rated, in the cost estimates, on a diminishing susceptibility scale, and the less susceptible may be omitted if either funds or time gives out—and the latter is just as likely to give out as the former. However, there are a number of conditions that interfere with this rating of comparative susceptibility to injury, and these are the factors that have frequently led to controversy.

During the past season an attempt was made to observe under what conditions normal food preferences of the beetles for shade trees may vary, and these observations are herewith briefly submitted.

Perhaps the most important factor causing deviations in comparative susceptibility to injury, or affecting the normal sequence of attack, is that of tree exposure to sunlight. Other factors being equal, isolated trees are more likely to be attacked than the same species in groups. Trees in narrow, shaded streets are less likely to be injured than those on thoroughfares open to sunlight during late morning and early afternoon. In group plantings, the outside trees exposed to sunlight are not only more likely to be attacked than the trees of the same species within the group but we have found no case of severe feeding upon the latter—the shady environment being very much of a repellent factor to the beetle. Large trees in street rows, which shade each other, are much less likely to be attacked than younger trees of the same species in the same exposed locality, but which are not large enough to shade each other, or which are in still more exposed locations.

Other factors being equal, young trees seem to be more susceptible to attack than older trees. Vigorously growing trees seem to be more severely injured than slower growing trees of the same species. The writer is not certain as to comparative susceptibility of healthy and unhealthy trees. Apparently, unhealthy trees which still maintain a good rate of growth are more susceptible to beetle attack than trees of the same species but of a healtheir type. This observation will need considerable confirmatory evidence before it may be more than tentatively accepted.

Consideration of conditions such as those mentioned above frequently explains why a less susceptible species is more severely injured than a more susceptible species, or why some trees are attacked when others of the same species are practically untouched in the same locality and where the same general density of beetle population occurs. Other factors being equal, the proximity of the trees to favorable breeding grounds—golf courses and lawns—will generally result in earlier and more severe injury.

It is important to establish the reasons for apparent deviations from food preferences. These observations were made in unsprayed communities. It is fully as important, and more significant to the economic entomologist to know what the reactions of the insect are in sprayed communities. Such observations are reported in Part II of this paper.

PRESIDENT W. B. HERMS: The next paper will be by G. F. McLeod.

SOME OBSERVATIONS ON JAPANESE BEETLE INJURY

Part II—Sprayed Communities

By G. F. MacLeod, *State College, Penna.*

ABSTRACT

Some results of a spraying demonstration for Japanese beetle, *Popillia japonica*, suppression are presented in which over 20,000 trees and shrubs received 77,525 gallons of lead oleate coated lead arsenate. Properly sprayed plants received 80 to 90 per cent protection. Damage to several species of trees not ordinarily attacked is noted.

INTRODUCTION

Several factors which influence the occurrence and degree of Japanese beetle injury in an unsprayed community have been mentioned. Of equal significance are the factors affecting injury in a sprayed community,—the reaction of the insects to their normal host plants, to those species ordinarily considered immune and to the spray material.

The Japanese beetle infestation was very severe in Jenkintown, Pennsylvania during the past season. The Agricultural Extension Service of the Pennsylvania State College conducted some educational work to demonstrate to this community that beetle protection was a practicable community operation. Beetle population here was as dense as anywhere within the infested territory. Many large lawns and a number of golf courses provided ideal conditions for grub development. The wide range of host plants growing in this region afforded an abundance of food for the beetles.

THE DEMONSTRATION

About 1000 properties of all types and sizes were included in this community. There were no plantings on 200 lots, most of which were places of business. Six unsprayed home grounds, on which normal food plants of the beetle occurred were widely scattered throughout the town. These served as a basis for comparison with the sprayed properties. Lead oleate coated lead arsenate was applied to more than 20,000 trees and shrubs. One complete application, using 77,525 gallons of poison spray was made to all trees, shrubs, vines, flowers and vegetables recorded[1] as being materially injured. The spraying was completed in 20 working days at a cost of $2200.

RESULTS

There were some variations in the degree of protection which was afforded susceptible varieties by the spray. Sprayed plants in general

[1]State of N. J. Dept. Agr. Circ. 134–135–136.

within the treated area were injured less severely than the same species on the outer boundaries of the demonstration. This was particularly evident where sprayed trees or shrubs abutted a golf course and an unsprayed woodland. A certain small degree of protection to unsprayed trees ordinarily attacked was obtained where these species occurred within the sprayed area. This protection was lost later in the season and unsprayed plants were defoliated. Foliage protection of from 80 to 90 per cent was secured for a period of about three weeks where the lead arsenate was properly applied.

Intensive spraying over such a large area unquestionably altered the normal feeding habits of the beetles. The adults attacked several species of plants which were unsprayed because they are not ordinarily injured sufficiently to warrant treatment. Among these are the following tree species, classified according to the extent of beetle feeding.

EFFECT OF COMMUNITY SPRAYING ON PARTICULAR TREES NOT NORMALLY INJURED BY BEETLES

Degree of Foliage Injury		
Severe	Moderate	Occasional
Pignut Hickory, *Carya glabra*	White Oak, *Quercus alba*	Black Oak, *Quercus velutina*
Chestnut, *Castanea dentata*	European Beech, *Fagus sylvatica*	Scarlet Oak, *Quercus coccinea*
Hop Hornbeam, *Ostrya virginiana*	Mockernut, *Carya alba*	American Beech, *Fagus grandifolia*
English Oak, *Quercus robur*, var.		
European Larch, *Larix decidua*		

Blueberry, common barberry, okra, asparagus and rhubarb were all severely damaged. Some of the plants mentioned will probably be attacked regardless of their occurrence in relation to sprayed or unsprayed areas. It is interesting to note, however, that the beetles fed more extensively on these plants within the sprayed area than on the same varieties at points remote from any spraying work.

An exceptional opportunity to observe the reaction of the insects to a large scale spraying operation was afforded by this demonstration. Five power sprayers advancing simultaneously in the same direction produced a very noticeable driving effect upon the beetles. The adults were driven off properties being sprayed and for the most part alighted three to five hundred feet ahead of the spraying machinery. This marked increase in numbers of the beetles on properties just in advance of the spraying operation suggested the possible economic utility of a

contact spray material in combination with the lead arsenate. In the ensuing two or three days the insects became more normally distributed, although there seemed to be a decrease in numbers of individuals throughout the entire season in the treated region.

It was anticipated that many dead beetles would be found in the community, but contrary to expectations no large numbers were found at any time. Several dead individuals were collected at widely scattered points within the demonstration area, but these were comparatively few in numbers. While this had little to do with the effectiveness of the spraying as a protective measure, there was an adverse psychological effect upon the home owners.

Summary

Observations in an extensive spraying operation indicate certain significant facts with regard to Japanese beetle injury under such conditions.

Sprayed plants well within the treated area suffered less injury than similarly treated specimens of the same kind located on the outer boundaries of the spraying demonstration. This factor indicates one value of cooperative spraying.

A small amount of protection was afforded to unsprayed plants ordinarily attacked where such species were surrounded by sprayed properties. This advantage was only temporary and defoliation occurred later in most cases.

Properly sprayed trees or shrubs received between 80 and 90 per cent protection from foliage injury.

In an area where all normal host plants were sprayed, several species ordinarily considered immune or only occasionally attacked suffered injury.

No large numbers of dead beetles were found in the sprayed community, but the operation resulted in driving off the insects present at the time, and materially reduced possible later infestation within the area treated.

President W. B. Herms: The next paper will be by R. B. Friend.

THE CONTROL OF THE ASIATIC BEETLE IN LAWNS

By R. B. FRIEND, *Assistant Entomologist, Connecticut Agri. Exp. Station*

ABSTRCAT

The control of the larvae of the Asiatic beetle (*Anomala orientalis* Waterhouse) in lawns can be accomplished by poisoning the soil with lead arsenate. The arsenate may be mixed with water and the resulting suspension sprinkled over the lawn, it may be mixed with a top-dressing of loam, or it may be incorporated in the upper inch of lawn soil. When applied as a suspension in water the amount recommended is three pounds of arsenate of lead per 100 square feet of lawn surface. When applied in a top-dressing of loam or incorporated in the upper inch of soil the amount recommended is two pounds per 100 square feet. The lawns should be treated before August 1st.

This paper is withdrawn for publication as part of a Bulletin of the Connecticut Agricultural Experiment Station.

ADJOURNMENT 12.15 noon.

Saturday Afternoon Session, December 29

The session convened at 1.40 p. m., Vice-President P. J. Parrott, presiding.

VICE-PRESIDENT P. J. PARROTT: The first paper is by H. W. Allen and R. W. Burrell.

METHODS OF OBTAINING EMERGENCE OF TIPHIA ADULTS FROM IMPORTED COCOONS FOR INTRODUCTION AGAINST THE JAPANESE BEETLE

By H. W. ALLEN and R. W. BURRELL

(Withdrawn for publication elsewhere).

PRESIDENT W. B. HERMS: The next paper is by Neely Turner.

VARIATION IN RESISTANCE OF APHIDS TO TOXIC SPRAYS

By NEELY TURNER, *Crop Protection Institute*

ABSTRACT

This paper points out the differences in resistance of aphids to a toxic spray. Attention is called to a simple method of applying contact insecticides. Results of sprays applied with this method are given.

Recent interest in the development of new contact insecticides has been responsible for considerable discussion of methods of testing such materials. A very accurate apparatus for laboratory tests of contact

insecticides has been developed by Tattersfield and Morris.[1] McIndoo and Sievers,[2] Richardson and Smith,[3] Griffin Richardson and Burdette,[4] English[5] and Peet and Grady[6] have discussed methods and insects for use in testing contact insecticides.

McIndoo and Sievers[2] and Richardson and Smith[3] recorded data which show that there is considerable variation in the resistance of different species of aphids to the same toxic materials. Aphids are very adaptable to toxicity tests and can be reared easily. Therefore a knowledge of the variation in their resistance to sprays is considered essential. A series of tests was run using controlled conditions and eliminating variation in method as much as possible to determine this variation in the case of the more common aphids. In this study a crude adaptation of the Tattersfield apparatus was used. This was made by fastening a stand made of one-fourth inch iron pipe in a heavy wood base. The pipe was so fitted that it held a No. 29 DeVilbiss atomizer with the nozzle pointing down. Directly under the nozzle and on the base, a cylinder of celluloid was supported in a permanent position an inch above the base in such a way as to allow the air currents to pass through. Inside the cylinder a petri dish cover served as a plate on which the aphids were placed. This cover was eight centimeters smaller in diameter than the cylinder. In the case of aphids feeding on leaves a leaf was cut from the plant and placed on the plate for spraying. In the case of aphids feeding on stems the cylinder was removed and the stem held and rotated by hand just above the plate. In all tests an air pressure of six pounds per square inch was used and the exposure was for five seconds. In this time approximately one cubic centimeter of spray fluid passed through the atomizer. In all cases "Black Leaf 40" at a dilution of 1 to 800 by volume was used. Immediately after spray-

[1]Tattersfield, F., and Morris, H. M. An apparatus for Testing the Toxic Values of Contact Insecticides under Controlled Conditions. Bul. Ent. Res., Vol. 14, pp. 223–233. 1924.

[2]McIndoo, N. E., and Sievers, A. F. Quassia Extract as a Contact Insecticide. In Jour. Agr. Res., Vol. 10, pp. 497–531. 1917.

[3]Richardson, C. H., and Smith, C. R. Studies on Contact Insecticides. U. S. D. A. Bul. 1160. 1923.

[4]Griffin, E. L., Richardson, C. H., and Burdette, C. Relation of Size of Oil Drops to Toxicity of Petroleum-Oil Emulsions to Aphids. In Jour. Agr. Res., Vol. 34, pp. 727–738. 1927.

[5]English, L. L. Some Properties of Oil Emulsions Influencing Insecticidal Efficiency. Ill. Nat. Hist Survey Bul., Vol. XVII, Art.V. 1928.

[6]Peet, C. H., and Grady, A. G. Studies in Insecticidal Activity. In Jour. Econ. Ent., Vol. 21, pp. 612–620. 1928.

ing the leaves or stems were placed in vials of water using cotton plugs to keep the aphids from crawling into the water. The vials were then placed under battery jars with a beaker of saturated sodium chloride solution which maintained a fairly constant humidity. The room temperature varied not more than 5°C. during these tests. Only apterous viviparous females were used. In check tests it was found possible to check results within 5 per cent.

The results of this series of tests are given in the following table.

Species	No. Tests	No. Dead	No. Alive	% Dead
M. solidaginis	6	245	348	41.3
M. rudbeckiae	3	69	90	43.4
M. solanifolii	3	408	280	59.3
A. rumicis	6	298	251	54.2
A. pseudobrassicae	5	563	231	70.9
A. gossypii	8	579	229	71.6
A. spiraecola	3	499	145	77.4

These results clearly show the variation in resistance of these species to the same spray applied under the same conditions. The smaller variations are insignificant, but the larger variations deserve consideration. These variations should always be considered in reporting tests of contact insecticides.

MR. WILLIAM MOORE: I would like to ask what spreader you used.

MR. NEELY TURNER: No spreader.

MR. WILLIAM MOORE: The reason for the question is the decided variation in the toxicity of Nicotine as determined by Professor Tattersfield and Professor Richardson. In the case of Professor Tattersfield, he used a spreader which would wet the insects very poorly and further he sprayed the insects only. In the case of Professor Richardson, the insects and the plants were sprayed and a spreader was used which actually wet the insects. In Professor Tattersfield's results, the kill was probably due to nicotine vapor evaporating from the body of the insect. In the case of Professor Richardson, one has a contact kill and the vapor kill, not only arising from the body of the insect but also from the leaves of the plant.

MR. NEELY TURNER: I didn't attempt to take into consideration all of these things. I tried to eliminate as many variables as possible and get as near as possible to the direct results. That is the reason there was no spreader of any sort considered.

MR. E. A. RICHMOND: I would like to ask Mr. Turner what he used for a sprayer.

MR. NEELY TURNER: I had a 29 DeVilbiss atomizer. You can get it at any drug store. The DeVilbiss people make all sorts of medical and perfumery atomizers. This I found to be the best. I tried five or six kinds and this gave a finer mist than any of the others. You attach a regular air line.

MR. F. E. GUYTON: What was the age of the aphids?

MR. NEELY TURNER: There was no selection as to age. There was a large population present in all cases.

MR. NATHANIEL TISCHLER: I would like to ask how conformable were the conditions in which these aphids were raised.

MR. NEELY TURNER: All of them were collected under natural conditions outdoors. It was practically all done in the month of August.

VICE-PRESIDENT L. S. MCLAINE: The next paper is by N. E. McIndoo.

A SUBSTITUTE FOR ARSENIC AS AN INSECTICIDE

By W. E. MCINDOO, *Washington, D. C.*

(Withdrawn pending further investigation)

MR. F. L. CAMPBELL: I should like to point out that it is very likely that pure cuprous cyanide has never been used. I think it is likely that cuprous cyanide always contains cupric copper. A great deal more ought to be known about the chemistry of cuprous cyanide. It is very possible that some of the foliage injury which has been reported by the use of cuprous cyanide may be due to cupric copper being present.

I also want to say that cage experiments of the kind reported by Mr. McIndoo, to my mind, do not determine relative toxicity. The mortality of insects in cage experiments depends not only on the toxicity of the compound, but also on other factors; that is, on the rate at which the poison is consumed, on the repellency or attractiveness of the compound. I believe that the true values for relative toxicity can be obtained only by determining the actual amount of the compound consumed by the insect. I believe that cage experiments determine relative effectiveness, not relative toxicity, of stomach-poisons.

MR. J. M. GINSBURG: I would like to ask Mr. McIndoo if he has tested the fungicidal value of this compound.

MR. N. E. NCINDOO: No, I have not.

VICE-PRESIDENT L. S. MCLAINE: The next paper is by B. F. Driggers.

EXPERIMENTS WITH TALC AND OTHER DUSTS USED AGAINST RECENTLY HATCHED LARVAE OF THE ORIENTAL AND CODLING MOTHS[1]

By BYRLEY F. DRIGGERS, Ph.D., *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

Preliminary laboratory tests with coarsely ground automobile tire mica dusted on peach foliage showed that a high per cent of newly hatched larvae of the Oriental Peach Moth were killed before they reached a point of entry. More extensive laboratory tests with a number of dusts showed that finely ground talc and mica killed a high percentage of Oriental Peach Moth larvae hatching from eggs on peach foliage dusted with these materials. Limited field tests with talc and mica showed that talc sticks better and is more effective than mica or hydrated lime in reducing larval entry into peach twigs. Limited tests with talc and mica dusted on foliage containing Codling Moth eggs showed that the young larvae of this insect are killed by both materials.

A careful study of the life history of the Oriental Peach Moth convinced the writer that one of the weakest points in the life cycle of the insect from the standpoint of artificial control measures is the interval from the time of hatching to the time of entry of the young larvae into the twigs or fruit. Only occasionally is an egg so placed that the hatching larva can enter the twig or fruit direct. If the point of entry is the fruit, the larva often has to crawl a foot or more before reaching its goal. In addition the larvae probably are more delicate at the time of hatching than any other time. It would appear therefore that sprays or dusts designed to act as a contact poison or a mechanical barrier to the young larvae would be more likely to succeed in controlling this insect.

PRELIMINARY TESTS WITH AUTOMOBILE TIRE MICA

Lubricating oils, and oils impregnated with pyrethrum and nicotine, used in a water emulsion were tried as ovicides and larvacides with varying degrees of success. Various dusts impregnated with nicotine were tried as well with indifferent results. Such materials as hydrated lime, sulfur and lead arsenate have been tested as mechanical barriers but were not effective unless heavy applications were made. It was apparent that some compound was needed which was more effective in stopping the larvae than the dusts commonly used in orchard spraying and dusting. In the search for an effective dust, the writer decided to test the dust that is used as a lubricant in automobile tires. It was re-

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

called that this dust was soft, light and made up of plate like particles which might be effective in preventing the larvae moving about freely. Inquiry revealed that the dust materials used as lubricants in automobile tires are "Mica," "Soapstone," and "Talc." A package of this material was obtained which was labeled "Automobile Tire Mica." The contents proved to be a coarsely ground dust of approximately 100 mesh.

The coarse mica dust was taken to the insectary and dusted lightly on peach foliage on which were Oriental Peach Moth eggs in the black spot stage. The eggs were observed to hatch normally and the larvae to start crawling to a point of entry. Now larvae of the peach moth crawl quite rapidly over the smooth surface of the peach foliage. However, on coming in contact with the dust particles, the larvae were effectively stopped. The particles of dust would adhere to the appendages and body and, in trying to extricate themselves or crawl forward, the larvae would accumulate a thicker coating of the dust. Those larvae crawling on the under side of the leaf or the upright stem were observed to lose their footing and fall. Closer observation revealed the fact that the larvae in most cases did not fall to the floor but suspended themselves from the foliage by means of a silken thread. Those larvae that became suspended from the surface in this manner were not able to regain their footing.

Another peach twig on which were approximately fifty eggs in the black spot stage was dusted with mica. A hole was punched in an apple and the peach twig thrust through several inches. The apple and twig was set in a bottle of water to keep the twig from wilting. The apple served as food for those larvae able to get through the coating of dust. The twig was dusted in the afternoon and examined the following morning. Fifty hatched eggs were found. Of the fifty larvae hatched, thirty-three were found dead on, or suspended from, the leaves and seven were found dead on the floor. A week later the apple was cut up and examined carefully for larvae; five larvae were found alive, leaving five unaccounted for.

Another test of the ground mica was made, using a larger number of twigs and with a suitable check. Eighteen twigs containing eggs were divided into four lots of four or five twigs each. Two of the lots were wet with water from an atomizer and the other two left dry. One wet and one dry lot was set aside to serve as a check. The remaining wet and dry lots were dusted with the ground mica. All of the twigs were thrust through apples and set in bottles of water. When all viable eggs were hatched the twigs in the four lots were examined for dead larvae. The results are given in Table 1.

TABLE 1. THE EFFECT OF GROUND MICA ON THE NEWLY HATCHED LARVAE OF THE ORIENTAL PEACH MOTH; THE DUST APPLIED ON WET AND DRY FOLIAGE BEFORE THE EGGS WERE HATCHED

Lot No.	No. of Twigs	Treatment	No. Eggs Hatched	No. Larvae Dead	No. Larvae Missing	% Larvae Killed Direct	No. Larvae Found in Apples
1	5	Check, wet leaves	51	0	51	0.0	28
2	5	Check, dry leaves	46	0	46	0.0	42
3	4	Mica dust, wet leaves	96	85	11	88.5	9
4	4	Mica dust, dry leaves	48	48	0	100.0	4

The data in Table 1 show that the mica dust killed a high percentage of the just hatched larvae, the percentage being 88.5 and 100 respectively for the wet and dry foliage. The figures in the last column show a fair recovering of missing larvae from the two check lots. The four larvae recovered in the apples in lot four were probably in the apples when picked from the tree.

FURTHER INSECTARY TESTS WITH DUSTS AS MECHANICAL BARRIERS TO YOUNG LARVAE

The next step in the investigation was to obtain from the Depart. ment of Commerce the names of manufacturers of mica and talc dusts. From two of these companies samples of 100 and 200 mesh mica and 200 and 325 mesh talc were obtained. It was believed that the physical properties of talc would cause it to be as good or better than mica for the purpose in mind.

A large number of peach twigs containing eggs were on hand when the two samples of talc arrived. These twigs—including eggs two, three and four days old—were divided into six lots of about twenty-five twigs each. Each twig was thrust through an apple and placed in a bottle of water in the usual manner. The treatments given the different lots are shown in column 3, Table 2. When sufficient time had elapsed for the eggs to hatch the twigs were examined carefully for dead larvae, care being taken to examine the squares of blotting paper for any larvae that may have fallen off and died.

TABLE 2. EFFECT OF DIFFERENT DUST MATERIALS ON THE ENTRY OF ORIENTAL PEACH MOTH LARVAE INTO TWIGS AND FRUIT

Lot No.	No. of Twigs	Treatment	No. Eggs Hatched	No. Larvae Dead	No. Larvae Missing	% Larvae Killed Direct	No. Larvae Found in Apples
1	25	Check	291	0	291	0.0	224
2	26	90–10 sulfur-lime	534	23	511	4.3	268
3	27	Hydrated lime	822	81	741	9.8	357
4	27	200 mesh talc	522	494	28	94.6	31
5	30	325 mesh talc	653	577	76	88.3	47
6	32	Auto tire mica	908	616	292	67.8	172

The data presented in Table 2 show clearly the superiority of talc and mica dusts over hydrated lime and sulfur in preventing the entry of the larvae into twigs and fruit. That the absence of dead larvae on the sulfur and lime dusted foliage was due to the failure of these dusts to stop the larvae is indicated by the considerable number of larvae maturing from the apples of these two lots. On examining the more heavily dusted parts of the foliage in the sulfur and lime lots, the writer observed numerous paths, showing that the larvae crawled over these dusted surfaces with little difficulty. No such paths were to be found on the talc and mica dusted foliage.

After the mica samples arrived an experiment was carried out to test the effect of the different meshed mica and talc samples. The method of rearing the larvae through an apple was discontinued in this and subsequent tests on the peach moth larvae. Those larvae that were free to move about, as was the case in the check lots and some of the least effective dusts, would either enter the twigs or crawl down the twigs and bottles and thus escape. A number of twigs—some with two and some with three day old eggs—were divided into five lots of eight or nine twigs each. The treatment given each of the lots is indicated in column three of Table 3. Each lot was placed on squares of white blotting paper and all sheltered in such a way that gusts of wind would not blow the larvae off the paper.

TABLE 3. THE EFFECT OF TWO TYPES OF TALC AND TWO TYPES OF MICA DUSTS ON THE RECENTLY HATCHED LARVAE OF THE ORIENTAL PEACH MOTH

Lot No.	No. of Twigs	Treatment	No. Eggs Hatched	No. Larvae Dead	No. Larvae Missing	% Larvae Killed Direct
1	8	Check	120	0	120	0.0
2	9	200 mesh talc	91	89	2	97.8
3	9	200 mesh mica	144	144	0	100.0
4	8	325 mesh talc	86	84	2	97.6
5	8	100 mesh mica	82	79	3	96.3

After sufficient time had elapsed for all the eggs to hatch each twig was examined carefully for dead larvae. The data, given in Table 3, show that the talc and mica dusts of both mesh killed a high percentage of the larvae. It should be pointed out, however, that the test was carried out in an insectary where the twigs were sheltered from blowing winds which might have blown off considerable amounts of one or all of the dusts. Later field tests showed that mica adhered to the foliage poorly, being blown off readily by winds.

Another test was run using the two mica and talc dusts in comparison with sulfur and hydrated lime. A half and half mixture of talc and mica was also tested. The procedure followed in this test was the same as that followed in the preceding test. The data from this test, given in Table 4, show that all the talc and mica dusts with the exception of the 100 mesh mica, killed 95 per cent or better of the larvae. The hydrated lime and sulfur killed less than half of the larvae under the same conditions.

TABLE 4. THE EFFECT OF 200 AND 325 MESH TALC, 100 AND 200 MESH MICA, HYDRATED LIME AND SULFUR ON THE RECENTLY HATCHED LARVAE OF THE ORIENTAL PEACH MOTH

Lot No.	No. of Twigs	Treatment	No. Eggs Hatched	No. Larvae Dead	No. Larvae Missing	% Larvae Killed Direct
1	9	Check	205	0	205	0.0
2	8	½ 200 M. talc ½ 200 M. mica	192	190	2	99.0
3	8	100 mesh mica	183	118	65	64.4
4	8	200 mesh mica	87	87	0	100.0
5	9	200 mesh talc	148	148	0	100.0
6	8	325 mesh talc	195	185	10	94.8
7	10	90–10 sulfur-lime	228	98	130	43.0
8	8	Hydrated lime	157	69	88	43.9

The experiments with talc and mica had not been under way long before the question began to be asked "Why are these two dusts more efficient than the other dusts tried?" This question leads to a number of interesting lines of investigation that will no doubt be taken up in time. It might be pointed out at this time that talc and mica are among the softer minerals and in the dust form they have a soft, soapy texture when rubbed between the fingers. Undoubtedly this physical characteristic is partly responsible for the ease with which the particles adhere to the larvae. The specific gravity of the material from which the dust is made as well as the size and shape of the particles themselves are some of the factors that may influence the action of the dusts. Electrical phenomenon may also play a part in determining whether a dust adheres strongly to the insect's body.

In order to obtain additional information on the effect of different kinds of dusts with different degrees of fineness and softness the writer secured ten dusts and tested them out at the same time in the usual way on recently hatched larvae of the Oriental Peach Moth. Care was taken to apply the dusts in as uniform a manner as possible. Table 5 shows the dusts used, their degree of fineness and the percentage of the larvae killed.

TABLE 5. A COMPARISON OF THE EFFECTIVENESS OF TEN DUSTS IN KILLING THE YOUNG LARVAE OF THE ORIENTAL PEACH MOTH

Lot No.	No. of Twigs	Material Used	Degree of Fineness	No. Eggs Hatched	No. Larvae Dead	No. Larvae Missing	% Larvae Killed
1	5	Check	———	119	0	119	0.0
2	5	Mica	200 mesh	101	98	3	97.0
3	5	Talc	200 mesh	87	80	7	92.0
4	5	Kaolin	Fine	64	44	20	68.7
5	5	Pumice stone	Coarse	85	16	69	18.8
6	5	$MgCO_3$	Coarse	120	23	97	19.1
7	6	SiO_2	325 mesh	187	113	74	60.4
8	6	China clay	325 mesh	142	128	14	90.1
9	6	"Abestine"	325 mesh	341	240	101	70.3
10	6	$CaCO_3$	325 mesh	182	58	124	31.8
11	5	Hydrated lime	Fine	115	55	60	47.8

An examination of the data in Table 5 will show that the talc and mica (200 mesh) gave a kill over 90 per cent. Out of four dusts that were finer than the talc and mica only one, china clay, killed as high as 90 per cent. The coarse dusts killed considerable less larvae than the talc and mica. That the fineness of the dust is of some importance is indicated if we compare the kill obtained in lots 5 and 6 (coarse dusts) with lots 4, 7, 8, 9, 10 and 11 (fine dusts). In the former only 19% of the larvae were killed while the average kill of the fine dusts is more than double this figure.

FIELD TESTS WITH TALC AND MICA DUSTS

At the time the dust tests in the insectary were being carried out peach twigs in the orchard had become hard. Since it was desirable to get some information on the effect of talc and mica in preventing entry of larvae into twigs in the field, the writer carried out the following test. Two, three year old peach trees were cut back and fertilized heavily in order to get new and vigorous growth as soon as possible. As soon as the trees began to send out new shoots the trees were caged to keep out the moths. When the new growth had reached several inches in length, twenty fertilized moths were released in each cage. After three days, during which time the weather was favorable for egg deposition, the cages were removed and one tree dusted with 200 mesh talc. The other tree was left untreated to serve as a check. Six days after the dust was applied heavy rains over a period of two nights and a day washed off most of the dust. As soon as the weather cleared the tree was redusted. Ten days after the first dust application was made all the new twig growth from the dusted and check trees was cut and a count of injured and uninjured twigs was made. The data from this test are

given in Table 6, first test. It may be seen from these figures that 118 out of 123, or 96%, of the twigs on the check tree were injured by the larvae. Twenty-nine out of 239, or 12.1% of the twigs on the dusted tree were injured.

TABLE 6. EFFECT OF 200 MESH TALC AND MICA AND HYDRATED LIME ON THE ENTRY OF YOUNG LARVAE OF THE ORIENTAL PEACH MOTH INTO PEACH TIWGS

Tree No.	Treatment	Total Twigs	No. of Twigs		% Twigs Injured
			Injured	Uninjured	
		1st. Test			
1	Nothing	123	118	5	96.0
2	200 Mesh talc	239	29	210	12.1
		2nd. Test			
1	Nothing	68	50	18	73.5
2	Hydrated lime	33	26	7	78.8
3	200 mesh mica	72	48	24	66.6
4	200 mesh talc	76	21	55	27.6

A second field test was run using 200 mesh talc, 200 mesh mica and hydrated lime. Four small nursery trees were caged and moths liberated to insure an infestation. Three of the trees were dusted and the fourth left to serve as a check. Rains on three different days during the time the eggs were hatching necessitated the renewal of dust coatings three times. In this test it was observed that the mica had very poor sticking qualities. A light breeze was sufficient to cause most of the mica dust to fall off. Both the talc and hydrated lime stuck until rains washed them off. The twigs on the four trees were cut and examined for larval entry two weeks after the moths were liberated in the cages. The results are given in Table 6, second test. These data show that in this test talc is superior to mica and hydrated lime in preventing larval entry into the twigs.

EFFECT OF TALC AND MICA DUSTS ON THE NEWLY HATCHED LARVAE OF THE CODLING MOTH

At the time the experiments with dusts were being carried out, the writer had available a small number of Codling Moths that had emerged from apples used in the rearing of Oriental Peach Moths. These moths were caged and twigs placed in the cage. Twelve twigs with eggs on them were obtained in the first lot. These were divided into three lots of four twigs each and treated as shown in Table 7, first test. The twigs were dusted and the larvae counted in the same way as were the Oriental Peach Moth twigs and larvae. In this test 71% of the larvae were killed by the 200 mesh talc, while only 19% were killed by the 200 mesh mica.

TABLE 7. EFFECT OF 200 MESH TALC AND MICA ON THE RECENTLY HATCHED LARVAE OF THE CODLING MOTH

Lot No.	Treatment	No. of Twigs	No. Eggs Hatched	No. Larvae Dead	No. Larvae Missing	% Killed Direct
			1st. Test			
1	Nothing	4	36	0	36	0.0
2	200 mesh talc	4	62	44	18	71.0
3	200 mesh mica	4	73	14	59	19.1
			2nd. Test			
1	200 mesh talc	3	11	8	3	72.7
2	200 mesh mica	2	12	12	0	100.0

On August 8, five more twigs with Codling Moth eggs were available. Three of them were dusted with 200 mesh talc and two with 200 mesh mica. No check was used. The results from this test, given in Table 7, second test, show that 72.7% of the larvae were killed in the talc lot and 100% of the larvae were killed in the mica lot. Observations were made on the Codling Moth larvae as they hatched and came in contact with the dust. They were affected in the same way as the Oriental Peach Moth larvae. Many of them suspended themselves from the edge of the leaf and were unable to get back to the surface. Some fell to the blotting paper below and, if they were only lightly coated with dust, managed to crawl away. From the limited tests and observation made on Codling Moth larvae, it was apparent that a heavier coating of dust was necessary to stop them than is necessary to stop Oriental Peach Moth larvae.

MR. J. J. DAVIS: Do you have any information on the rate of application?

MR. B. F., DRIGGERS: The rate at which the dusts were applied was not determined. The dust coatings were made as nearly equal as was possible throughout the experiments.

MR. J. J. DAVIS: Is the surface white?

MR. B. F. DRIGGERS: No. The applications were not heavy enough to mask the green color of the foliage. I would say that the applications were about as heavy as those ordinarily encountered in peach orchard dusting.

MR. P. GARMAN: I would like to ask the speaker if these materials with fluosilicate were compared with talc and mica dust.

MR. B. F. DRIGGERS: No, I did not; only the dusts shown in the tables were used.

VICE-PRESIDENT L. S. MCLAINE: The next paper is by Hugh Glasgow.

MERCURY SALTS AS SOIL INSECTICIDES

By HUGH GLASGOW

ABSTRACT

Various salts of mercury have been found effective in checking injury by such soil inhabiting pests as the cabbage maggot (*Hylemyia brassicae*), the carrot rust fly (*Psila rosae*), and the onion maggot (*Hylemyia antiqua*).

Of the various compounds examined mercurous chloride is especially noteworthy, as much on account of its great safety to the crop treated as because of its efficiency as an insecticide.

Mercurous chloride promises to be an exceedingly useful insecticide, particularly in the treatment of tender crops such as cauliflower and celery seedbeds, as well as in certain types of greenhouse work.

In addition to its insecticidal properties, mercurous chloride also appears to have considerable fungicidal value in checking certain seedbed diseases.

Since its introduction eight or nine years ago as a soil insecticide, mercuric chloride has come to be one of the most useful materials available for combating the root maggots of cruciferous crops.

While the efficiency of mereuric chloride, when applied for this purpose, cannot be questioned, injury to certain crops has occasionally been reported following its use. Mercuric chloride solutions, in the proportion generally recommended, are safe and effective; but they must be used with care, and it must be admitted that the margin of safety for such tender crops as cauliflower seedlings is not very great even when the dosage is cut down to the minimum.

On this account it seemed worth while, if possible, to find some compound of mercury less toxic to the plant but that would still retain the valuable insecticidal properties of mercuric chloride.

With this object in mind a systematic examination of the different available compounds of mercury was planned. Of the compounds so far studied during the past three seasons, mercurous chloride has given the most promise of fulfilling these requirements. For the present, therefore, the discussion will be limited to a consideration of the merits of this compound as compared with the standard dilutions of mercuric chloride as commonly recommended.

Mercurous chloride, calomel, or mild mercuric chloride, as it is sometimes termed by the dealer, is a heavy, white powder practically insoluble in water, and generally regarded as an exceedingly inert substance. For this reason it was tested in the regular course of the work more as a matter of routine, as nothing much was expected from it as an insecticide.

Preliminary tests soon suggested, however, that this apparently inert compound really did possess surprising insecticidal properties when placed in the soil, and this was borne out by later detailed tests on a number of different insect pests. In fact it was found possible with this material to secure more definite and complete control of pests such as the cabbage maggot, onion maggot, and carrot rust fly than with any of the other insecticides available. This was due chiefly to the fact that on account of its extreme safety to the plant the dosage could be increased almost without limit, where with most of the other insecticides suitable for this purpose the limits of safety are much more sharply defined.

In carrying out these tests the mercurous chloride was applied in a number of different ways with the idea of establishing the limits of safety to the plant and its insecticidal properties as well as any possible value it might have as a soil fungicide for use against seedbed diseases.

The usual method of applying was in an aqueous suspension, by first making the required amount into a paste and later adding this to the bulk of the water. When used in this way the proportions arbitrarily taken in most of the routine tests were one ounce, four ounces, and eight ounces respectively to ten gallons of water, the resulting suspensions being constantly agitated as they were applied.

In addition to this method of applying, the mercurous chloride was also used as a 4 per cent dust in an inert carrier such as finely powdered gypsum. In this form it was usually drilled along the row directly on the seedlings so that there would be a continuous deposit of the dust on the ground immediately about the base of the plants to be protected.

Finely powdered mercurous chloride has the property of adhering tenaciously to certain smooth coated seeds such as cabbage or cauliflower.

On account of this quality it is possible to coat such seed very thoroly with an exceedingly heavy film of the powder by the simple process of agitating the seed for a short time in a vessel containing finely powdered mercurous chloride. By such a procedure a pound of cauliflower seed should retain somewhat more than half its weight of the powder distributed as a uniform film surrounding the individual seeds.

Seeds of various kinds coated in this way were planted, and as a further check on their tolerance to this material heavy applications of the pure powder were also made at the time of seeding so that the seed when covered was surrounded in the soil by the powder.

Even with such an excessively heavy application of the pure mercurous chloride directly to the seed in the soil, the seed of cabbage,

cauliflower, radish, onion and a number of other crops were found to germinate normally, the young seedlings pushing thru this deposit of pure mercurous chloride with no apparent injury. In some cases there even appeared to be a noticeable stimulation in the development of the seedlings due possibly to the mercurous chloride inhibiting the growth of injurious soil fungi. Such heavy applications of mercurous chloride to the seed at the time of planting were made at first with the idea of testing the tolerance of the germinating seedlings to the chemical and to establish also the effect of such heavy applications on the development of seedbed diseases. It soon became apparent, however, that when applied in this way and with no subsequent treatment certain crops were protected to a marked degree from the attack of insect pests such as the root maggots and that frequently this protection persisted thruout the remainder of the growing season.

The results of two typical tests illustrating the effect of such seed treatments in preventing root-maggot injury are given in Tables 1 and 2.

In the first of these tests, four plots of onions were treated in the following manner at time of seeding: In Plot 1 the seed before planting was coated heavily with the powder in the manner already described, after which it was planted in the usual way. In Plot 2 the seed was first drilled into an open furrow and a heavy application of the powder sifted directly on the seed, after which it was covered with earth. In the third plot the two methods of applying the powder were combined so that the application was nearly twice as heavy as in either one or two. The fourth plot was reserved as a check.

In each of the plots there were approximately 340 plants in the beginning. Two months after seeding, when counts were made, fifty per cent of the plants in Plot 1 had been killed by maggot attack, altho those remaining were sound and the degree of control was very definite.

In Plot 2 where the powder was drilled into the row with the seed the loss was only about 4 per cent, while in the third plot it was even somewhat less.

In this experiment the insects were present in overwhelming numbers as is indicated by the almost complete destruction of the plants in the check plot. Under ordinary conditions the control, even in Plot 1, would have been much better; and the plants might easily have been carried thru with no apparent loss.

Table 2 shows a similar series of tests carried on in a cauliflower seedbed. Here the infestation while heavy was not excessive, and the control in Plot 1 where the seed was treated before planting was as complete at the end of the season as in that receiving the heavier dosage.

There was no apparent injury to the plants, even in Plot 3, which received an extremely heavy application to the seeds.

In Table 3 the applications of mercurous chloride were made directly to the growing plants, in this case a cauliflower seedbed. The root maggot infestation in this planting was not extremely heavy, but a comparison of the different treatments may be taken as typical of similar tests that were made.

At the standard concentration of one ounce to ten gallons of water the mercurous chloride in this series appears to be somewhat less effective than corrosive sublimate in checking root maggot injury. It should be noted, however, that this is about the greatest concentration at which corrosive sublimate can safely be used in treating cauliflower seedbeds; while, on the other hand, by increasing the amount of mercurous chloride somewhat it is possible to secure an appreciably greater control without any sacrifice of safety.

In the case of Plot 5 the addition of mercurous chloride to a solution of corrosive sublimate gave somewhat better control than when used separately.

Mercurous chloride, as might be expected, appears to be somewhat slower in its action in the soil than the more soluble corrosive sublimate, but on the other hand it also retains its insecticidal properties over a much longer period. For this reason it may in some cases be an advantage to combine the two, particularly where corrosive sublimate is being used and it is desired to increase the concentration beyond the limit where this material can be used with safety.

Mercurous chloride applied as a four per cent dust in an inert carrier such as gypsum also proved effective in controlling the cabbage root maggot as indicated for Plot 7.

The value of mercurous chloride as compared with a number of other insecticides in checking the carrot rust fly is shown in Table 4.

It will be noted from this table that while a number of the other materials listed reduced the infestation appreciably, mercurous chloride either in aqueous suspension or as a dust was the only insecticide in the list that gave complete protection. Also while some of the other treatments reduced the crop considerably as a result of injury, there was no apparent injury following the use of mercurous chloride.

Conclusions

The studies on mercurous chloride so far carried out indicate that this material promises to be an extremely useful insecticide for use against certain types of soil inhabiting insect pests such as the root

maggots. The fact that it combines the qualities of great efficiency with almost unlimited safety to the crop treated makes it an insecticide of great promise. This applies particularly to the protection of extremely tender crops, such as cauliflower or celery seedbeds, on which most of the other insecticides available for root-maggot control are likely to cause injury.

In addition to its value as an insecticide, mercurous chloride when applied as for root-maggot control has in some cases shown marked results in checking certain seedbed diseases, notably club-root and damping-off troubles in cabbage and cauliflower seedbeds. Used alone or in combination with mercuric chloride it appears to have great promise in checking such seedbed diseases irrespective of its value in the control of insect pests.

TABLE 1. INFLUENCE OF MERCUROUS CHLORIDE IN PREVENTING ONION MAGGOT INJURY

Method of applying	Approximate Number of Plants Originally Present	Number Plants Killed by Maggots	Percentage Loss Due to Maggots	Injury From Treatment
Seed thoroly coated	340	168	50.4	none
Drilled in with seed	340	14	4.1	none
Seed coated, also drilled in with seed	340	7	2.6	none
Check	340	335	98.5	——

TABLE 2. INFLUENCE OF MERCUROUS CHLORIDE IN PREVENTING ROOT-MAGGOT INJURY IN CAULIFLOWER SEEDBED

Method of Applying	Total Number Plants in Plot	Number Plants Infested	Percentage Plants Infested	Injury from Treatment
Seed thoroly coated	286	none	none	none
Drilled in with seed	269	none	none	none
Seed coated, also drilled in with seed	292	none	none	none
Check	257	212	82.5	——

TABLE 3. INFLUENCE OF MERCUROUS CHLORIDE IN CONTROLLING CABBAGE MAGGOT IN CAULIFLOWER SEEDBED

Treatment	Plot	Number of Applications and Percentage Clean Plants			
		1	2	3	4
Mercuric chloride solution, 1 oz. to 10 gals	1	92	97	100	100
Mercurous chloride suspension, 1 oz. to 10 gals.	2	88	98	97	100
Mercurous chloride suspension, 4 ozs. to 10 gals.	3	96	100	100	100
Mercurous chloride suspension, 8 ozs. to 10 gals.	4	100	100	100	100
Mercuric chloride 1 oz. to 10 gals. / Mercurous chloride, 1 oz. to 10 gals.	5	94	100	100	100
Organic mercury, 4 ozs. to 10 gals	6	86	95	100	100
Mercurous chloride, 4% dust	7	87	100	100	100
Check	8	54			

TABLE 4. VALUE OF MERCUROUS CHLORIDE IN COMPARISON WITH A FEW OTHER SOIL INSECTICIDES IN THE CONTROL OF THE CARROT RUST FLY

Insecticide	Number of Applications Made and Percentage Clean Plants Obtained				
	1	2	3	4	5
Mercuric chloride (aqueous solution)	0	6	27	68	80
Mercurous chloride, 1 oz. to 10 gals. (aqueous suspension)	0	18	87	86	100
Mercurous chloride, 4 ozs. to 10 gals. (aqueous suspension)	46	97	100	100	100
Mercurous chloride (dust)	100	100	100	100	100
Naphthalene (dust)	0	3	17	84	72
Derris (dust)	0	0	0	2	3
Lead arsenate (dust)	0	1	0	6	15
Tobacco dust	0	0	0	8	14
Bordeaux-Lubricating oil emulsion, 2%	2	0	12	21	30
Check	0	0	0	0	0

The above materials under Table 4 were applied at weekly intervals for five consecutive weeks for the control of the second brood.

VICE-PRESIDENT L. S. MCLAINE: The next paper is by R. L. Miller

MANGANESE ARSENATE AS A CONTROL FOR THE CODLING MOTH

By RALPH L. MILLER, *Assistant Entomologist, State Plant Board, Sanford, Florida*

ABSTRACT

Manganese arsenate when used in the laboratory alone or with lime was not quite as effective in preventing the entrance of newly hatched codling moth larvae into carefully sprayed apples as was arsenate of lead. When mixed with lime-sulphur or lime and lime-sulphur there was little difference in the effectiveness of the two materials. The addition of lime, lime-sulphur or both, decreased the efficiency of both manganese arsenate and lead arsenate. In the field experiments manganese arsenate gave as good or better results when mixed with lime-sulphur as did arsenate of lead. Arsenate of lead was slightly better than manganese arsenate when each was used alone. The residue of manganese arsenate was more easily removed than was that of arsenate of lead.

The following paper is an account of one season's intensive program using Manganese arsenate in comparison with arseniate of lead as a control for the codling moth. Laboratory work in which apples were uniformly sprayed with the various mixtures and then infested with newly-hatched codling moth larvae, were carried on to check field experiments in three different places in Ohio and one place in Washington

This work was supported by the Grasselli Chemical Company as a fellowship at the Ohio Agricultural Experiment Station and was under the direct supervision of Professor J. S. Houser, Chief of the Department of Entomology.

Laboratory Methods

Rearing.—In order to obtain a supply of eggs and newly hatched larvae, infested apples were collected from many orchards near Wooster, Ohio. These were placed in glass cylinders 6″ x 12″ set on a screen to allow for ventilation. Small strips of corrugated paper were scattered over the apples and a cheese cloth tied over the top.

The spun up larvae were collected every few days and placed in fresh cylinders. When the adults emerged, 40 to 60 were placed together in a glass cylinder 6″ x 12″ set on a glass plate. A watch glass containing a wet cloth, and a few pear leaves were placed in the cylinder and a cheese cloth tied over the top.

Eggs were deposited on the sides of the cylinder, on the bottom plate and on the leaves. The cylinders were changed daily. This method of rearing was that used by Dr. W. S. Hough of Winchester, Virginia, who very willingly suggested it to the writer.

Preparation of Apples for Spraying.—Baldwin apples from a commercial orchard at Wooster, Ohio, that had been sprayed according to the regular spray schedule for that section, were used. The arsenical residue present was removed by immersion for two minutes in a 2% solution of hydrochloric acid. The calyx end was cut out and the cavity filled with shellac. Only uniform and previously uninjured apples were used in the work.

Spraying of Apples.—The apparatus shown in Plate 14, Fig. 1 was used to spray all apples in the laboratory.

It consisted of a motor driven air pump and compressed air tank. This discharged through a pressure regulating valve to an atomizer. The spray mixture was kept thoroughly agitated by an electric mixer. The apple was suspended a little off center from the shaft of the small water motor and while rotating slowly was sprayed for ten seconds at 7.5 lb. pressure. This procedure resulted in a thorough and uniform cover on every apple. Plate 14, Fig. 2.

After being sprayed the apples were suspended from racks as shown in Plate 14, Fig. 3 and when thoroughly dry the larvae or eggs were placed on them.

Twenty-four apples were used for each material. On each of twelve of these were placed 25 newly hatched larvae and on each of the other

twelve were placed leaves containing 25 eggs. Thus 300 larvae and 300 eggs were used for each material.

The young larvae were handled by means of a soft camel's hair brush and the eggs on the leaves were attached by means of a paper clip. A few apples in each plot were sprayed daily and larvae or eggs were placed on each plot daily in order to overcome any variation in vitality of various batches of larvae or eggs. All the work was carried on in a basement laboratory.

Recording Results.—One week or ten days after the larvae were put on the apples each apple was cut open and examined to determine the number of entrances and stings.

Field Methods

Spraying.—All field spraying, four applications in Ohio and nine applications in Washington, were made at 300 pounds pressure or above.

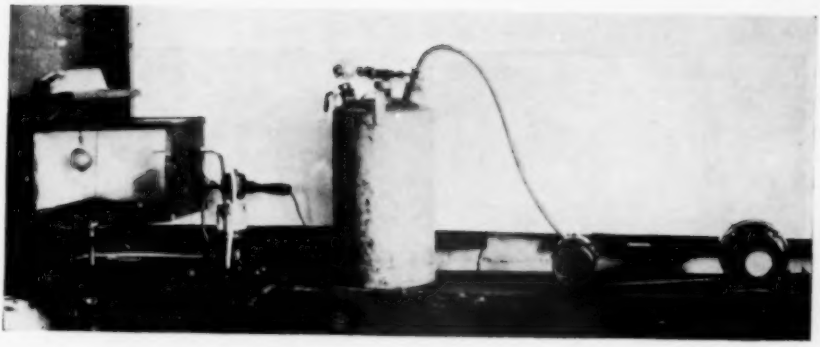
Recording Results.—Two trees with fairly good crops that were known to have been well sprayed and did not receive drift from another plot were chosen for each plot as counters. All of the fruit on these trees was inspected and counted.

The field counts in Ohio were begun by counting all the dropped apples under the especially chosen trees during late July. The dropped apples were counted three times before harvest and at picking time. Each apple was examined and the number of apples having calyx entrances, side entrances, stings or no injury was recorded.

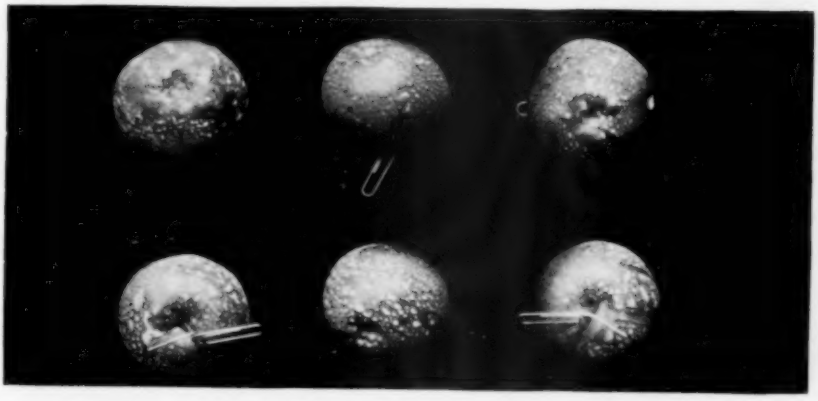
Results

Effect on Foliage.—Manganese arsenate caused no perceptible injury to foliage in Ohio. A count of dropped leaves under trees sprayed with arsenate of lead and those sprayed with manganese arsenate showed a few more fallen leaves under the manganese arsenate than under the lead but this injury was not noticeable on the tree.

In Yakima, Washington, however, a few growers received severe burning of foliage after using manganese arsenate. In Wenatchee, Washington, one instance of fruit burning was reported after the use of manganese arsenate. In both cases, however, arsenate of lead used in adjoining orchards showed a very similar burning but somewhat less severe. Very high temperatures accompanied by difficulties in maintaining the level of irrigation water probably exaggerated the injury. The experimental plot at Yakima that had received nine applications showed no injury whatsoever.

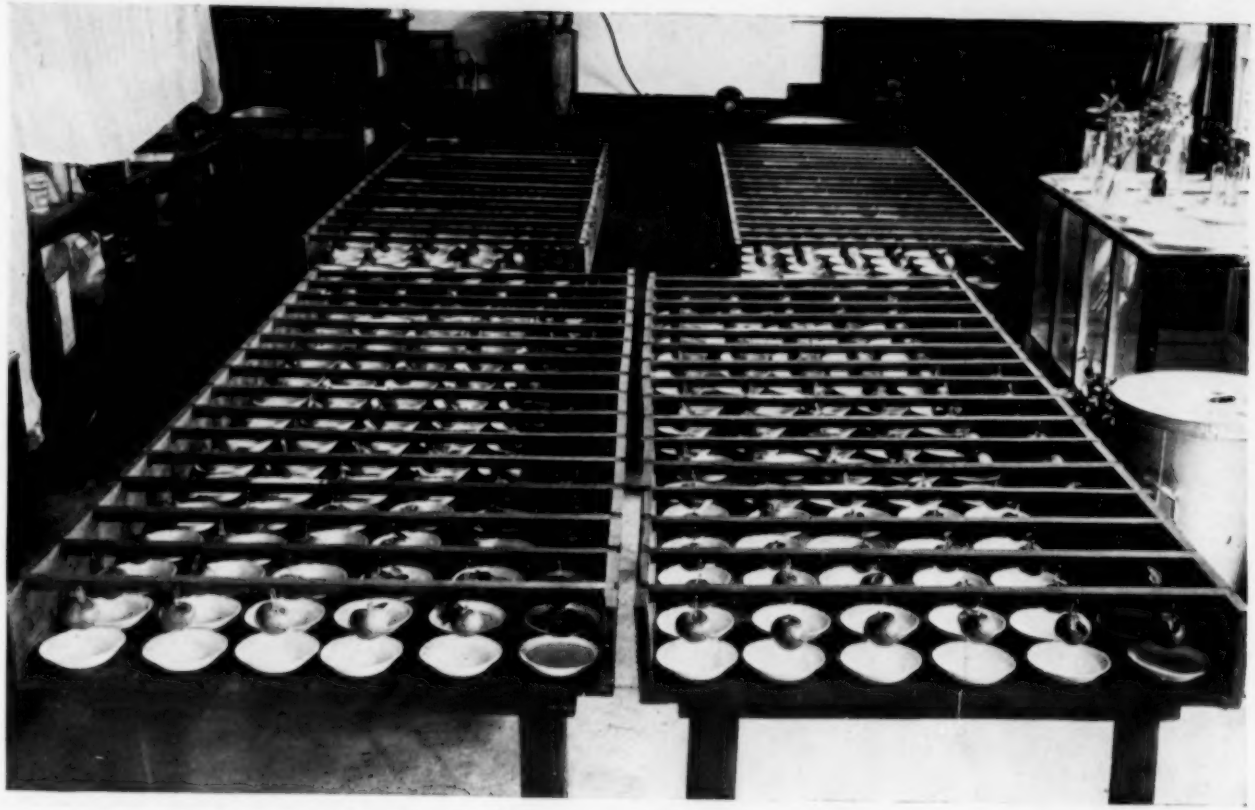


1.—Apparatus used for spraying apples in laboratory.



2.—Cover secured by spraying apples in laboratory with atomizer.

3.—Method of suspending sprayed apples.



Tables with racks for suspending the sprayed apples.

RESIDUE REMOVAL.—Residue tests were made on comparatively small Jonathan apples from the Neely orchard in Yakima, Washington. This orchard received nine applications of spray material during the season and at picking there was considerable visible insecticide on the fruit. The analyses were made in duplicate by a commercial testing laboratory in Yakima.

TABLE 1. RESIDUE IN GRAINS PER POUND OF APPLES

	From Tree	Wiped	Washed
Manganese Arsenate, 1 lb.–50 gal.	.056	.019	.0042
Manganese arsenate, 1 lb.–50 gal., spreader	.032	.028	.0055
Arsenate of lead, 1 lb.–50 gal.	.097	.04	.011

It was found that occasionally a heavy residue spot of manganese arsenate prevented the coloring of the apple under the spot. This was especially true of early varieties. When a spreader was used there was no such difficulty.

In comparing the manganese arsenate plot of Greenings at Gypsum, Ohio, with the adjoining arsenate of lead plot there seemed to be less russeting on the fruit sprayed with manganese arsenate. The fact that manganese arsenate in a mixture with a lime sulphur solution does not form a black sludge as does arsenate of lead, may be of significance in this case but no work was carried on relative to this point.

EFFECT ON CODLING MOTH.—The following charts will show the results of the work using manganese arsenate and arsenate of lead against the codling moth.

TABLE 2. RESULTS OF LABORATORY WORK SHOWING THE PER CENT OF LARVAE THAT CAUSED INJURY TO APPLES SPRAYED WITH MANGANESE ARSENATE AND LEAD ARSENATE USED ALONE, WITH LIME, WITH LIME SULPHUR AND WITH LIME AND LIME SULPHUR

	Entrances %	Stings %	Total %
Manganese Ars. 1¼ lb., Water 50 gal.	4.5	35.5	40.0
Lead Ars. 1¼ lb., Water 50 gal.	7.0	25.1	32.1
Manganese Ars. 1¼ lb., Water 50 gal.	7.3	31.8	39.1
Lead Ars. 1¼ lb., Water 50 gal.	2.3	15.0	17.3
Manganese Ars., 1¼ lb., Lime 3 lb., Water 50 gal.	18.5	13.5	32.0
Lead Ars., 1¼ lb., Lime 3 lb., Water 50 gal.	11.0	10.6	21.6
Manganese Ars., 1¼ lb., L. S. 1¼ gal., Water 50 gal.	29.3	15.5	44.8
Lead Ars. 1¼ lb., L. S. 1¼ gal., Water 50 gal.	20.5	17.6	38.1
Manganese Ars. 1¼ lb., Lime 3 lb., L. S. 1¼ gal., Water 50 gal.	37.6	5.6	43.2
Lead Ars. 1¼ lb., Lime 3 lb., L. S. 1¼ gal., Water 50 gal.	46.4	2.4	48.8
Check (Water)	49.8	4.3	54.1

TABLE 3. RESULTS OF FIELD EXPERIMENTS SHOWING THE KINDS AND EXTENT OF CODLING MOTH INJURY IN PER CENT OCCURRING ON FRUIT SPRAYED WITH VARIOUS MIXTURES OF MANGANESE ARSENATE AND LEAD ARSENATE

	Yakima, Washington (Jonathan)				(Winesap)			
	Calyx %	Side %	Sting %	Total %	Calyx %	Side %	Sting %	Total %
Manganese Ars. 1 lb., Water 50 gal.	1.6	19.5	15.8	36.9	.8	9.9	11.8	22.5
Manganese Ars.,1 lb., Fluxit spreader, Water 50 gal.	2.1	29.8	16.4	48.3	.8	11.9	11.2	24.0
Lead Ars. 1 lb., Water 50 gal.	.4	9.1	6.7	16.2	.0	7.1	6.4	13.5
	Gypsum, Ohio (Greenings)				Marietta, Ohio (Rome Beauty)			
Manganese Ars. 1¼ lb., Lime Sulphur 1 gal., Water 50 gal.	.6	9.8	11.7	22.1	.08	2.1	6.3	8.4
Lead Ars. 1¼ lb., Lime Sulphur 1 gal., Water 50 gal.	.4	18.1	13.8	32.3	.02	2.0	7.4	9.4
Check (no treatment)	24.7	55.1	1.4	81.2	23.0	44.4	3.2	70.6
	Delaware, Ohio (Rome Beauty)							
Manganese Ars. 1¼ lb., Lime 1 lb., L. S. 1 gal., Water 50 gal.					.13	9.5	15.1	24.7
Manganese Ars. 1¾ lb., Lime 1 lb., L. S. 1 gal., Water 50 gal.					.06	3.5	8.6	12.16
Lead Ars. 1¼ gal., Lime 1 lb., L. S. 1 gal., Water 50 gal.					.04	5.9	21.4	27.34
Check (no treatment)					8.0	31.8	8.4	48.2

EFFECT OF MANGANESE ARSENATE ON OTHER INSECTS

COLORADO POTATO BEETLE

(*Leptinotarsa decemlineata* Say)

Laboratory tests were made in which arsenate of lead and manganese arsenate both at the rate of 2 lbs. per 50 gal. of water were sprayed on potato foliage artificially infested with larvae of the Colorado Potato Beetle. The larvae fed very little on foliage sprayed with either insecticide and within five days each material had killed 89.3% of the larvae. Four per cent of the larvae in the check were dead. Manganese arsenate did not injure potato foliage.

BLACK BLISTER BEETLE

(*Epicauta pennsylvanica* DeG.)

Both manganese arsenate and arsenate of lead failed to control the Black Blister Beetle at four pounds per fifty gallons of water but as a

dust at full strength both killed 72% in 48 hours. When the beetles were sprayed with four pounds of manganese arsenate in fifty gallons 2% volck, they were all killed in 48 hours. Manganese arsenate did not injure aster foliage.

Conclusions

From the rather extensive field tests described in the preceding pages it will be noted that in many cases the manganese arsenate is equal or superior to arsenate of lead, while in some cases it is practically on a par with arsenate of lead. The use of manganese arsenate in conjunction with the various addition agents, such as lime, lime-sulphur, etc., indicates about the same effect on toxicity in the case of the manganese arsenate as is indicated on lead arsenate; and certain advantages with dispersing agents or spreaders are indicated in connection with the use of manganese arsenate, particularly on early varieties of apples.

Since manganese arsenate has given as good control as lead arsenate in Ohio orchards and fairly satisfactory control in Washington orchards (counts in Washington limited to three varieties—Jonathans, Stamens and Winesaps); has caused damage in only a few isolated spots and leaves a smaller amount of arsenical residue than arsenate of lead, which residue is more easily removed than that of arsenate of lead, it is the opinion of the writer that this insecticide is worthy of further research and investigation, especially in view of the fact that the material is still in the developmental stage, and such imperfections as have been indicated are easily susceptible of improvements or entire elimination.

Vice-President L. S. McLaine: The next paper is by D. M. DeLong.

THE ROLE OF BORDEAUX MIXTURE AS A LEAFHOPPER INSECTICIDE

By Dwight M. DeLong,[1] *Columbus, Ohio, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Experiments in the control of the potato leafhopper, *Empoasca fabae* Harris, on both potato and bean show that treatments with pyrethrum extracts have an immediate action upon the leafhoppers but do not affect the individuals which hatch a few hours after treatment. The leafhoppers which fed upon plants treated with Bordeaux mixture did not show any decrease in numbers for the first 24-hour period,

[1]Professor of Entomology, Ohio State University. This work was performed while the writer was employed as Field Assistant on the Bean Insect Project, Truck Crop Insect Investigations, Bureau of Entomology, U. S. D. A.

but after the lapse of this time there was a gradual decline in the insect population until none remained alive after 3 or 4 days. The nymphs hatching after treatment were also killed. Leafhoppers which were thoroughly wetted with Bordeaux mixture were not affected. Experiments of the several types conducted indicate that the copper from the Bordeaux mixture is absorbed by the plant, and demonstrate that Bordeaux mixture has a direct insecticidal action upon leafhoppers.

Although several of our recent text books (*2, p. 75; 3, p. 80–81; 4, p. 260–262*)[2] have stated that Bordeaux mixture is merely repellent to insects, previous work, especially that by Fenton and Hartzell (*1*), had shown that it is a definite insecticide, at least for the potato leaf-hopper, *Empoasca fabae* Harris. Fenton's and Hartzell's preliminary experiments, in which leafhoppers were enclosed in shell vials on single leaves taken from plants sprayed with Bordeaux mixture, indicated that this spray material was strongly toxic, but in no case was it shown that tests were made with insects which were given no opportunity to come in contact with the sprayed surfaces of the leaves; nor were treated leafhoppers placed upon untreated foliage.

The experiments recorded herein were undertaken to bring out if possible the exact manner in which Bordeaux mixture acts as an insecticide. In these experiments leafhoppers were confined to growing bean plants and were kept under as nearly normal conditions as possible. The entire plant was used in the majority of the tests and the leafhoppers were free to move about on the plant after treatment. In general the results of these experiments have coincided with those of Fenton and Hartzell in so far as these workers have gone into this problem.

During the past three seasons comparative tests, the results of which are still unpublished, have been made by the writer with a variety of materials for the control of the potato leafhopper upon both bean and potato. In these tests insecticides like pyrethrum extracts killed the leafhoppers within a few hours after the spraying. However, they had no effect upon the young leafhoppers which hatched a few hours after treatment, consequently a new leafhopper population was soon built up. In experiments with Bordeaux mixture it was observed that there was no immediate effect upon the leafhoppers, for at the end of 24 hours after spraying the leafhoppers were as abundant as at the time of application. After this period, however, they gradually died until, at the end of three or four days, all had succumbed.

Observation a week after spraying showed no new leafhopper populations and the newly hatched nymphs were dead. The most interesting phases of this control of the leafhopper by Bordeaux mixture seemed to

[2]Numbers in italics refer to literature cited at end of paper.

be a delayed but certain killing of the individuals present and a continued lethal action of the material, for a considerable length of time after application, which effectively controls the individuals hatching after treatment. In view of these observations upon field plots, a series of more detailed experiments was carried on in the season of 1928 with the view of ascertaining the exact role of Bordeaux mixture in the killing process.

Since it is a common field practice in leafhopper control to spray the crop when the insect is present, the spray thus coming in contact with the leafhopper, this procedure was used as a starting point for the experiments herein recorded. Experiments of this character showed that nymphs of all stages were dead 24 hours after the spraying, and that at the end of 4 days not more than 5 per cent of the total leafhopper population survived. At the end of 6 days after treatment all the leafhoppers usually were dead. The leafhoppers apparently feed as normally upon the treated plants as they do upon untreated plants and furthermore there is no indication that they attempt to leave the sprayed plants for unsprayed plants. Leafhopper checks upon untreated plants under conditions exactly the same as those upon treated plants showed 85 per cent survival of the leafhoppers at the end of 6 days.

Is Bordeaux Mixture a Contact Insecticide?

In view of these results obtained by spraying plants when the leafhoppers were on the plants, a series of experiments was carried on to determine if possible whether Bordeaux mixture kills by contact with the insect. In the opinion of the writer there are two ways to approach this problem and by employing these methods to determine the action of the Bordeaux mixture on the leafhoppers in the series of experiments discussed in the foregoing paragraph. The first consists of spraying the plants and of placing the leafhoppers upon them after the Bordeaux mixture has dried, thus eliminating the possibility of the spray covering the insects. The second method is to cover the leafhoppers thoroughly with the Bordeaux mixture and then place them upon untreated plants, thereby ascertaining whether this material has any value as a contact insecticide. Both of these methods were tried.

Several hundred leafhopper nymphs and a few adults were tested by the first method mentioned. The time intervening after treatment and before the insects were put on the plant was varied greatly in different tests. These tests showed that the leafhoppers all died within four or five days when they were placed on the plants a few hours

after treatment. When placed on treated plants in from 15 to 23 days after spraying the leafhoppers died in approximately the same length of time as they did when placed on the plant a few hours after spraying. This would indicate very strongly that it is not necessary to strike the insects with spray material in order to kill them. On the other hand, it would not prove that the spray material striking the insects' body would not kill the leafhoppers.

The second method mentioned, that is, first spraying the leafhoppers and then placing them on untreated plants, was next tested. Leafhopper nymphs were sprayed in a container in order to effect a thorough drenching. It was necessary in many instances to rescue the insects from the surface of a pool of Bordeaux mixture where they had fallen in a seemingly half-drowned condition. Many of them were not active for several minutes after the treatment. The leafhoppers were then placed immediately upon untreated plants where they fed normally during the remaining days during which they were under observation. In spite of this severe treatment less than 5 per cent had died at the end of 6 days after spraying, and those alive were apparently in normal condition and developed to the adult stage. In some of these tests all the leafhoppers survived the contact treatments and remained alive from 10 to 12 days.

In order to eliminate the effect upon the leafhoppers of the residue of Bordeaux mixture as they come in contact with it when dry upon the leaves, plants, one or more days after having been sprayed, were washed thoroughly under running water, the leaf being cleaned as completely as possible without mutilating the tissue. By this method all visible stains and residue of Bordeaux mixture were removed. Leafhoppers placed on plants treated in this manner all died in 4 or 5 days. The period required to kill the insect corresponded in these experiments to that in the experiments in which the plant foliage was still covered with the spray at the time the leafhoppers were allowed to feed upon it. Typical symptoms indicating that the insects were being killed by the Bordeaux mixture resulted as in the other case.

In view of the negative results which were obtained from the experiments to determine the value of Bordeaux mixture as a contact insecticide, and in the light of previous results obtained by other workers upon the effect of Bordeaux mixture as a stimulating agent to plant tissue, a series of experiments was carried on to determine the effect of Bordeaux mixture upon the leafhoppers when they were permitted to feed upon Bordeaux-sprayed plants but were prevented from coming in contact with the spray material on the plant. In order to carry out

these tests it was necessary to prevent the parts of the foliage upon which the insects fed from being hit by spray material. It was also necessary to inclose the insects in a specially constructed feeding cage so as to confine their feeding to the unsprayed part of the foliage. Only the upper surface of the leaves was treated, and the insects were caged on the lower surface.

Special Feeding Cells

Different types of glass feeding cells (Plate 16) were tested, and the best results were obtained with pieces of glass tubing about 2½ inches long and of approximately the same diameter with a ring of chamois cloth a little wider than the thickness of the glass wall glued on the edge of the glass at one end. This cloth when brought in contact with the leaf surface makes a closely fitting joint between the lower surface of the leaf and the glass cell without injury to the leaf or the veins. The pubescence of the leaf and the hairy fiber of the cloth prevent the leafhoppers from escaping between the edge of the glass where, because of the large veins on the under surface of the leaf, it does not touch the leaf tissue. The other end of the glass cell was covered with thin cheesecloth to allow free circulation of air. By the use of "stilts" made of heavy wire and placed in the ground the feeding cells can be adjusted to any height desirable to accommodate the plant leaf. In this position the leafhoppers can feed normally under controlled conditions.

Experiments With Feeding Cells and Their Results

In these experiments only the upper surface of the large leaves of the plant were sprayed, the under surface of each leaf being carefully covered to prevent fine spray from striking it. By proper adjustment of these feeding cells the leafhopper nymphs were permitted to feed from the under side of the leaves having Bordeaux mixture on the upper surface. It was found that a considerable area of leaf tissue was necessary for the continued feeding of only a small number of leafhoppers since they were able to take the cell sap from a small unit of leaf tissue in a very short time. The plant juices are apparently pumped through the body of the leafhopper in large quantities as in the case of many aphids. This was evidenced by the quantity of excrement deposited on the walls of the feeding cells. It was necessary therefore to use not more than five or six leafhoppers at one time in a single cell and to use a number of cells in order to have a representative number of insects in each experiment. Glass feeding cells of this type were used as checks on untreated plants in exactly the same way and with the same number of

leafhoppers to a cell. The results of these tests were interesting and may perhaps best be shown by the data from three specific series which are representative of all tests made as regards relative results.

In one set of these tests an examination 5 days after the leafhoppers had been placed on the plants showed that 60 per cent had died and that less than 5 per cent of those in the check had died. At the end of 10 days the treated plants showed 82 per cent dead and the check still less than 5 per cent.

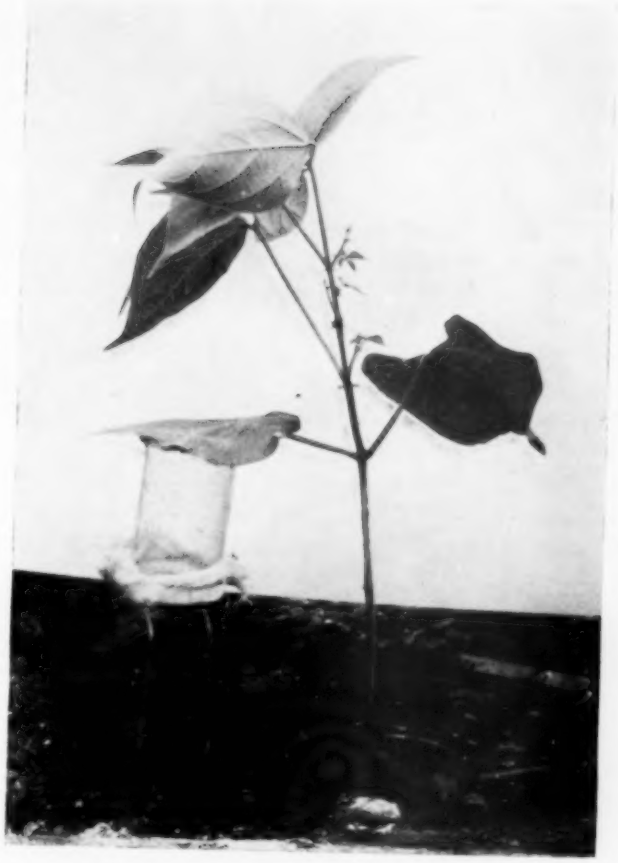
A second series gave, 7 days after treatment, 84 per cent dead on the treated plants and 50 per cent dead on the checks, and at the end of 14 days 95 per cent dead on the treated and 50 per cent dead on the check plants. This mortality on the check plants was the highest shown in any of the checks in the series and is given here to show the extreme of this condition. Even here, however, the percentage dead was much greater upon the treated plants. It was also quite evident in this case that another factor, the presence of a natural enemy, had contributed to the death of some of the leafhoppers upon the check plants. A third series, performed when temperatures were much lower and when the rates of feeding and metabolism were consequently much slower, showed in 10 days 50 per cent dead on the treated plants and 18 per cent on the check plants; and at the end of 14 days 62 per cent dead on the treated plants and 18 per cent dead on the check.

The rate of killing was slower in all the experiments in which cells were used than in cases where the insects were placed on plants having Bordeaux mixture on both surfaces of the leaves. Since only one surface of the leaf was sprayed, however, the quantity of Bordeaux mixture present on the leaf was only about one-half as much as in these other tests and consequently the quantity diffusing into the leaf must have been correspondingly less

While these tests have not proven conclusively the point in question, they have given strong indications that these leafhoppers obtained copper in some form from the leaf tissue upon which they fed and were apparently obtaining this copper from the cell sap. We already know that when sprayed upon the leaves Bordeaux mixture acts in some cases as a stimulant to plant tissue, and that other insecticides in the soluble form are taken up by the plants (*5*), and the indication from these leafhopper tests is in accordance with this known effect upon the plant.

In all cases plant roots were sufficiently protected, while the plants were being sprayed, to prevent any Bordeaux mixture from getting into

PLATE 16



Special feeding cell or cage employed for feeding leaf hopper from under side of leaf only. Note cell or cage supports.

the soil or coming in contact with the roots. In the field, however, absorbtion of Bordeaux mixture through the roots might be an added factor in leafhopper control.

Observations during these experiments would indicate that certain conditions or symptoms are characteristic of leafhoppers which die from the effects of feeding upon foliage sprayed with Bordeaux mixture. In these individuals the characteristic bright green color is replaced by a yellowish color in from 20 to 48 hours after they have begun to feed. In 2 or 3 days they become weakened or inactive and fall from the plants. After once dropping from the plant they are unable to get back or to move about in any decided way, and if placed on the plant they are not able to remain on it. This condition seems to be linked more or less with the most characteristic feature of poisoning from Bordeaux mixture, that is, the inability of the insect to molt successfully. The great majority of poisoned insects die during the molting process. This fact was also noted by Fenton and Hartzell (*2*). The process of molting begins as usual and the anterior portion of the body is usually freed from the cast skin, but the leafhopper is unable to free the last pair of legs and the posterior portion of the abdomen and dies in this partially molted condition. In the emerging adult the wings are still curled and the body is frequently strongly arched at the middle and remains this way until death occurs. If carefully freed from the skins the leafhoppers do not live very long. This seems to be a case of death due to a weakened condition although it is possible that the molting fluids are affected chemically, especially since the cast skins sometimes show a light copper-blue color instead of the normal white coloration.

Small nymphs are more quickly killed than those in the fourth and fifth instars. If only first, second, and third instar nymphs had been used in all of these tests, not only would the length of time for killing have been reduced but the percentages of killing would have been greater, if we may judge from the relative percentages of small nymphs killed. Many of the large nymphs successfully molted to the adult stage before death, which occurred from 1 day to 10 days afterward in some cases. As a rule, if a large nymph is to molt successfully to the adult stage, it is necessary that this emergence take place within 48 hours after the leafhoppers are placed on the treated plants. Where experiments were carried on with adults, the data obtained would indicate that a much smaller percentage is killed and that a longer time is required for killing.

What Strength of Copper is Necessary for Killing?

Standard Bordeaux 4–4–50 was used in most of these tests. In the preparation of the material 6 pounds of hydrated lime was substituted for 4 pounds of stone lime in most cases. Comparative tests were made with different quantities of copper sulphate ranging from 1 to 5 pounds. By summarizing all the tests made with each strength of Bordeaux mixture the following results are found: At the end of 6 days after treatment the 1–2–50 Bordeaux mixture showed 86 per cent dead, the 2–4–50 strength gave 90 per cent control, the 3–5–50 strength gave 100 per cent control, and the 5–8–50 gave 90 per cent control. These differences in the percentage of control should not be considered as indicating any particular differences in the effectiveness of the various mixtures of different strengths. The results would indicate, however, that even a relatively small percentage of copper in the Bordeaux mixture is effective for leafhopper control and that it is probably not necessary to use as strong Bordeaux mixture as has been the custom in the past. Data taken from treated plots in the field conform with the results of all the detailed experiments. Bordeaux-mixture dusts when dry have a definite repellent action upon the leafhoppers, but when dusted upon a wet plant surface they seem to act in very much the same way as do Bordeaux-mixture sprays.

After tests and observations in the field for three seasons and detailed experiments in the insectary for some three months there is no doubt in the writer's mind that Bordeaux mixture should be classed as an insecticide for the potato leafhopper. All the results from the experiments conducted on this problem would indicate very clearly, however, that Bordeaux mixture is not a contact insecticide, since leafhoppers sprayed with it were not killed and there is slight probability that the leafhoppers which come in contact with the dry residue on the sprayed plants are affected directly by this spray residue. Otherwise it will be difficult to explain why the sprayed plants, which were later washed, caused the leafhoppers to die with typical symptoms of Bordeaux poisoning and especially why the leafhoppers feeding on foliage sprayed with Bordeaux mixture, but which never came in contact with the spray in any form, died in the same manner as those placed upon the sprayed plant. Apparently the only insecticidal factor common to all these experiments was the copper from the Bordeaux mixture which was absorbed by the plants. This would indicate that the application of spray to the *plant* is the factor of primary importance.

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MR. P. J. PARROTT: I would like to ask a question. Dr. De Long said that the amount of copper used apparently had no effect. When you use the same amount of copper dust as compared with spray, there is a noticeable effect and I would like to know what would be his explanation for that.

MR. D. M. DE LONG: I didn't say anything about the dust, but I can answer that question in this way. The dry dust acts as a repellent. The leafhoppers will not feed on a plant with a dry dust. I can't keep them on the plant. If the plant is thoroughly wet, the Bordeaux dust acts very much like a Bordeaux spray.

MR. P. J. PARROTT: Do you get the duration of the effectiveness the same?

MR. D. M. DE LONG: The Bordeaux dust is not effective as long, according to the experiments I have performed.

MR. F. Z. HARTZELL: Do you think that the toxicity is due to the plants taking up the copper from the Bordeaux mixture?

MR. D. M. DE LONG: I think it is. I can only assume what happens there the same as I can with other conditions. The work of Swingle and certain others indicate that plants take up the materials in spray solutions very quickly through the stoma of the leaf. They have indicated that the under surface of the leaf will take them up more rapidly than the upper surface, which accounts, I believe, for the fact that the hoppers died more slowly where they were allowed to feed in their normal condition on the lower surface of the leaf than when the upper surface was treated. That would be my explanation, although I have no proof of it at all.

PRESIDENT W. B. HERMS: The next paper is by Albert Hartzell.

TOLERANCE OF DIFFERENT SPECIES AND VARIETIES OF PLANTS TO NAPHTHALENE VAPOR

By ALBERT HARTZELL, *Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.*

ABSTRACT

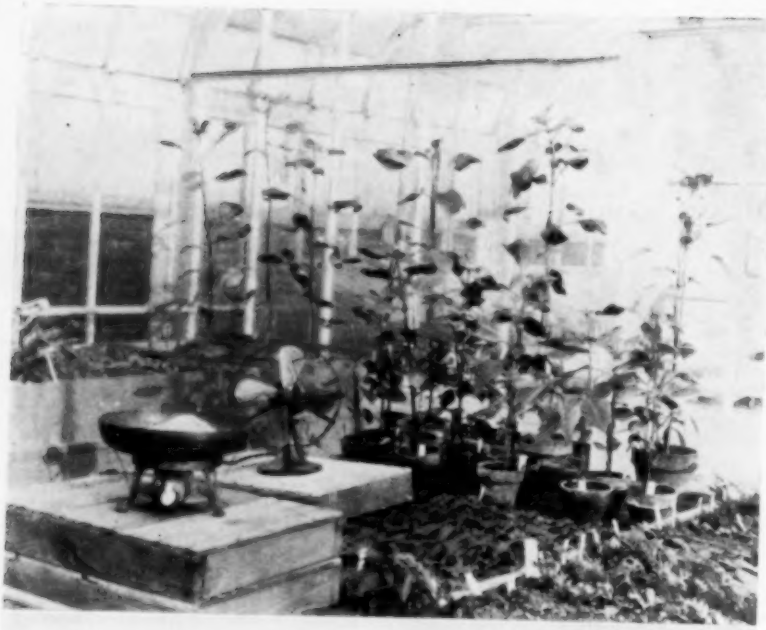
One hundred and fifty species and varieties of plants were tested to determine their tolerance to naphthalene fumigation with concentrations of 1.5 ounces and 2 ounces for each 1,000 cubic feet of greenhouse space. Dahlia proved to be one of the most tolerant species. Single fumigations at the higher concentration were effective in the control of red spider (*Tetranychus telarius*), two species of thrips (*Heliothrips femoralis* and *Thrips tabaci*) and a slug (*Limax maximus*). At the lower concentration repeated fumigations at intervals of 4 or 5 days were necessary to obtain satisfactory control.

INTRODUCTION

For a number of years naphthalene has been employed in England as a greenhouse fumigant for the control of red spider (*Tetranychus telarius*) (1, 2, 3, 5, 6, 8) on cucumbers, tomatoes, and certain other plants. It has not as yet come into general use for that purpose in America. In a previous paper (4) the writer presented the results of some preliminary experiments which indicated that naphthalene fumigation might be adapted for certain plants under greenhouse conditions. As a result of this work repeated fumigations with 1.5 ounces of naphthalene to each 1,000 cubic feet of greenhouse space were recommended for the control of thrips and red spider. Darrow (9) using somewhat higher concentrations reports success in controlling red spider on strawberries and a number of other horticultural plants. Parker (7) employing naphthalene from an English source, was able to use under certain conditions approximately 13 ounces for each 1,000 cubic feet without serious injury to plants and (3) recommends 8 ounces per 1,000 cubic feet of greenhouse space. In our experiments, doses of 1.5 ounces and 2 ounces for each 1,000 cubic feet gave concentrations sufficiently toxic to kill red spider and thrips. A few species and varieties of plants were injured even at these relatively low concentrations. The present paper is an attempt to bring together the data on plant tolerance to naphthalene which have accumulated as the result of a number of greenhouse fumigations during the last two years.

MATERIALS AND METHODS

The naphthalene (melting point 174.2°F.) used in these fumigations was sold under the trade name of "Polar Bear Naphthalene" and was purchased from the Barrett Company, New York City. The com-



Above—Apparatus for volatilizing naphthalene set up in greenhouse for night fumigation of dahlia plants. The fan distributes the vapor throughout the house.

Below—Electric hot plate and steel evaporating dish containing the naphthalene.

pany's representative stated that it was derived from an American source. Both ground and flake naphthalene were used in these tests with equal degrees of success.

The duration of exposure was from 12 to 15 hours, usually beginning about 5:30 P. M., and ending the following morning not later than 7 o'clock, after which the house was thoroughly aired. The size of the houses ranged from 5,000 to 6,000 cubic feet. Dosages of 1.5 ounces or 2 ounces for every 1,000 cubic feet of greenhouse space were used. The greenhouses were maintained at 70°F. and 80% relative humidity as nearly as possible. The naphthalene was volatilized by means of a special lamp described in a previous publication (4) or was placed in a steel evaporating dish on an electric hot plate. The hot plate was operated at "high" heat until the naphthalene was melted and then changed to "medium" at which temperature (approximately 175°F.) it was continued throughout the entire period of exposure. The naphthalene was allowed to volatilize over a period of from four to six hours since less injury to foliage results when the vapor is driven off slowly. An electric fan was used to circulate the air in the house. This was done to avoid injury to foliage through uneven distribution of the vapor. After fumigation the plants were kept under observation for a week. Frequent examinations were made throughout this period to determine whether the red spider and thrips revived or not, and whether injury to foliage resulted.

Results

In the course of these experiments one hundred and fifty species and varieties of plants were tested to determine their tolerance to naphthalene fumigation. The following were uninjured when fumigated over night with naphthalene at a concentration of 1.5 ounces per 1,000 cubic feet of greenhouse space:

Althaea rosea (hollyhock)
Asclepias nivea
Avena sativa (oat)
Beta vulgaris (beet)
Brassica oleracea var. *capitata* (cabbage)
Calendula officinalis
Callistephus chinensis (China aster)
Centaurea imperialis
Coleus blumei
Cosmos bipinnatus
Cucumis sativus (cucumber)
Dahlia sp.
Daucus carota var. *sativa* (carrot)
Fragaria vesca (strawberry)
Gaillardia grandiflora
Gossypium hirsutum (cotton)
Helianthus annuus
Hippeastrum equestre
Holcus sorghum (sorghum)
Hordeum vulgare (barley)
Hyacinthus orientalis
Lactuca sativa (lettuce)
Mirabilis jalapa (four o'clock)
Pelargonium sp. (geranium)
Prunus persica (peach)
Scabiosa atropurpurea

Secale cereale (rye)
Sinapis alba (mustard)
Solanum melongena var. *esculentum* (egg-plant)
Solanum tuberosum (potato)
Sonchus oleraceus
Spinacia oleracea (spinach)
Tagetes erecta
Trifolium hybridum (alsike clover)
Tropaeolum majus (nasturtium)
Zea mays (corn)

The foliage of buckwheat (*Fagopyrum esculentum*), red clover (*Trifolium pratense*), pepper (*Capsicum annuum* var. *longum*), radish (*Raphanus sativus*) and tomato (*Lycopersicum esculentum*) showed a few small dead areas when concentrations of the above strength were used, whereas soy beans (*Glycine max*) had extensive areas of necrotic tissue on the leaves. The very oldest leaves of certain plants sometimes respond to naphthalene fumigation by turning yellow and dropping prematurely when no other evidence of injury is present. The following plants were uninjured when fumigated with naphthalene at the rate of 2 ounces for each 1,000 cubic feet of greenhouse space:

Abutilon hybridum
Ageratum sp.
Ailanthus glandulosa (tree of heaven)
Ambrosia artemisiifolia
Anchusa officinalis
Anethum graveolens (dill)
Asclepias nivea
Azalea amoena
Azalea indica var. *alba*
Bellis perennis
Bryophyllum sp.
Buxus sempervirens (boxwood)
Castanea pumila (chinquapin)
Celastrus scandens
Centaurea imperialis
Chrysanthemum sp.
Chrysanthemum maximum (Shasta daisy)
Clematis paniculata
Coreopsis tinctoria (calliopsis)
Dahlia sp.
Varieties:
Arthur
F. T. D.
Insulinde
Jersey's Beauty
Trentonian
Warner
Yellow Jewel
Deutzia scabra
Didiscus caerulea
Eupatorium ageratoides
Evonymus japonicus
Forsythia intermedia
Gardenia jasminoides
Hedera helix (English ivy)
Helianthus tuberosus (Jerusalem artichoke)
Hibiscus syriacus (Rose of Sharon)
Hippeastrum equestre
Holcus sorghum (sorghum)
Hydrangea opuloides
Ilex aquifolium (English holly)
Ilex glabra
Ilex opaca
Iris sp.
Juniperus virginiana (red cedar)
Lathyrus odoratus (sweet pea)
Lavandula spica (lavender)
Ligustrum vulgare (privet)
Mentha spicata (spearmint)
Morus rubra (mulberry)
Myrtus communis (myrtle)
Nephrolepis exaltata var. *bostoniensis* (Boston fern)
Opuntia sp.
Perilla nankinensis
Phacelia whitlavia
Picea abies (Norway spruce)
Pimpinella anisum
Plantago lanceolata (ribgrass plantain)

Portulaca oleracea
Prunus persica (peach)
Pyrus malus (apple)
Rhododendron maximum
Ribes rubrum (red currant)
Rose var. Dorothy Perkins
Rudbeckia hirta
Secale cereale (rye)
Sedum sp.
Stachys lanata
Stevia serrata
Syringa vulgaris (lilac)
Taxus canadensis (yew)
Thuja occidentalis (arbor vitae)
Tradescantia discolor
Tragopogon porrifolius (salsify)
Tsuga canadensis (hemlock)
Tulipa gesneriana var. *darwinia*
Valeriana officinalis (heliotrope)
Vinca minor

The foliage of black currant (*Ribes nigrum*), geranium (*Pelargonium* sp.), nasturtium (*Tropaeolum majus*), *Lythrum salicaria* var. *roseum*, *Nemaria tryumph*, *Nycterinia capensis*, *Magnolia* sp., *Maurandia* sp., *Linaria* sp., *Nemesia* sp., and *Matricaria alba* showed a small amount of marginal burning after fumigation at the above mentioned strength. The following plants were severely injured at this concentration:

Fuchsia speciosa
Lycopersicum esculentum (tomato) old plants
Martynia proboscidea
Nemophilia sp.
Nicotiana langsdorffii
Nicotiana longiflora
Nicotiana nudicaulis
Nicotiana paniculata
Nicotiana plumbaginifolia
Nicotiana quadrivalvis
Nicotiana repanda
Nicotiana rustica
Nicotiana sanderae
Nicotiana suaveolens
Nicotiana sylvestris
Nicotiana tabacum
var. *gigantia*
var. *purpurea*
Nicotiana trigonophylla
Oxalis sp.
Papaver sp. (poppy)
Papaya seedlings
Philadelphus sp. (mock orange)
Physalis pubescens
Plantago major (broad leafed plantain)
Rose var. Button hole
Schizanthus wisetonensis
Vitis vinifera (grape)

The stage of growth of the plant appears to have important bearing on tolerance. The older leaves are more sensitive to naphthalene injury than young tender foliage.

Naphthalene seems to show selective toxicity for certain animals. Red spider (*Tetranychus telarius*), two species of thrips (*Heliothrips femoralis* and *Thrips tabaci*) and a slug (*Limax maximus*) were killed by naphthalene fumigation. The mortality in most cases was complete when the dose was 2 ounces for every 1,000 cubic feet. When lower concentrations were used repeated fumigations at intervals of 4 or 5 days were necessary to give satisfactory control. Naphthalene was not found to be a satisfactory fumigant for aphids and white fly at the concentrations used.

Discussion

Naphthalene fumigation is still in the experimental stage. The present paper reports the tolerance of certain plants to fumigations at relatively low concentrations. It is planned to continue this investigation by testing the tolerance of plants at the higher concentrations, which have been used successfully in England, to determine whether under American conditions they are preferable to the relatively low concentrations used in our experiments.

It should be noted that the optimum conditions for naphthalene fumigation are quite different from those suitable for cyanide. A high relative humidity (70–80%) is necessary in the former, but very undesirable in the latter case. Cyanide fumigation is well established as an effective control for aphids and white fly, but it has not proved to be satisfactory against thrips and mites. On the other hand, naphthalene because of its selective toxicity for thrips and red spider appears to fill this need better than any other known fumigant. Since naphthalene fumigation is not established as a common greenhouse practice in this country, it is suggested that first trials with plants of unknown tolerance be conducted cautiously to avoid unnecessary injury to foliage. In addition care must be exercised not to fumigate tomato and cucumber fruits in the later stages of growth because they may be rendered inedible by the retention of the flavor of naphthalene. Naphthalene is an inexpensive material and relatively non-injurious to man and higher animals.

Of the plants tested in this series dahlia was one of the most tolerant. In the greenhouse it is very susceptible to injury by thrips and red spider. By means of naphthalene fumigation it has been found possible to free dahlia from these pests. It is believed that this fumigant will prove of value to growers interested in propagating dahlias from seedlings and cuttings under glass.

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MR. C. A. WEIGEL: I would like to ask Dr. Hartzell if he has used the steam pipes as a means of liberating the naphthalene.

MR. ALBERT HARTZELL: No, I haven't.

MR. C. R. CROSBY: Did you try it on Cyclamen and Begonia?

MR. ALBERT HARTZELL: I have tried it on the Cyclamen but not in a sufficient number of trials to make any statement as to tolerance. It will kill the Cyclamen mite. I understand it has been used by commercial growers for that purpose.

MR. C. R. CROSBY: Did you try Begonia at all?

MR. ALBERT HARTZELL: I haven't tried it.

MR. W. P. FLINT: I might add that we have tried naphthalene this year in a rather large scale test on the cyclamen mite and have had very good control. We got better control, however,with Paradichlorobenzene.

MR. W. D. WHITCOMB: In Massachusetts a commercial material composed of Naphthalene and paradichlorobenzene is now being used quite successfully by a method similar to that just described to control the red spider on carnations.

MR. P. J. PARROTT: In New York the ivy is getting to be a very popular plant in households, the plants being run over a trellis in the parlor, verandas and so forth. Under those circumstances, a very difficult pest to combat by the ordinary procedures recommended is the red spider. I was wondering if Dr. Weigel or Dr. Hartzell would give us the benefit of their advice as to the handling of plants under those situations where the humidity is variable. You can't use sprays in a parlor or on a veranda. What would you suggest to meet a condition of that character?

MR. ALBERT HARTZELL: What was the pest?

MR. P. J. PARROTT: Red spider on ivy.

MR. ALBERT HARTZELL: Where you have low humidity coming in, I am afraid you will get burning.

MR. P. J. PARROTT: That is what they don't have; they don't have humidity.

I send these people—they are usually old ladies of some means and so forth, and they are almost as troublesome as my own garden; I never can protect that—bulletins from the government and from the states bearing on the question, but they don't seem to be enthusiastic about the measures prescribed.

MR. WILLIAM MOORE: Did you try the bathtub or the kitchen sink?

MR. P. J. PARROTT: They can't handle them.

MR. WILLIAM MOORE: You can take them down and put them up again.

MR. P. J. PARROTT: No, they are attached to a trellis; it is a hard situation. And I have tried personally some of these standard insecticides recommended and which seem so simple as they are described in the paper, but they don't work.

PRESIDENT W. B. HERMS: The next paper is by D. F. Barnes and S. F. Potts.

ADHERENCE OF SOME DUST MATERIALS

By D. F. BARNES and S. F. POTTS, *Melrose Highlands, Mass.*

(Paper not received by editor)

PRESIDENT W. B. HERMS: The next paper is by J. M. Ginsburg.

A CORRELATION BETWEEN OIL SPRAYS AND CHLOROPHYLL CONTENT OF FOLIAGE[1]

By JOSEPH M. GINSBURG, Ph.D., *Biochemist in Entomology, New Jersey Agricultural Experiment Station*

ABSTRACT

Two varieties of apple trees received several spray applications of a highly refined lubricating oil during the months of July and August. No injury to foliage or fruit was observed from these late sprays. The leaves on these trees were darker green, appeared more vigorous, and exhibited a later leaf drop than those of either unsprayed trees or trees which received other sprays. Chemical analysis disclosed the fact that the oil sprayed leaves of both varieties contained appreciably more chlorophyll than did the leaves from the unsprayed trees.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

Introduction

During the summer of 1928 an investigation was started by Dr. T. J. Headlee, with the assistance of the author concerning the effect of summer oil sprays, containing definite concentrations of pyrethrum extracts, on codling moth and other insects. Large blocks of apple trees located in a commercial orchard near Moorestown were selected for this purpose. In order to facilitate frequent and close observations on the effect of these sprays on foliage and fruit as well as on insect control, the above experiments were repeated, altho somewhat later in the season, on a small scale in the college orchard. While the results of the entire investigation will be published in due time, this paper is concerned only with preliminary studies on the effect of oil sprays on the amount of chlorophyll present in leaves.

Altho the problem of applying summer oil sprays either for their direct insecticidal value; or as carriers for other insecticides; or as adhesives is still in the experimental stage, the immediate and cumulative effects of these sprays on foliage and fruit created wide interest among scientific workers in this field. It has been frequently observed under conditions prevailing in New Jersey that oil sprayed foliage exhibited a darker green color than did the unsprayed foliage of the same variety of trees. This increase in color intensity becomes so pronounced after several successive spray applications that the oil sprayed trees can be readily distinguished from the other trees. Of course, only highly refined mineral oils, freed from unsaturated and aromatic hydrocarbons (2, 3, 7) can be applied with comparative safety to fruit and foliage.

Experiments with different oils (5) carried out under climatic conditions prevailing in New Jersey have shown that a highly refined oil, similar in viscosity to that of "nujol" or about 200 Saybolt/100 did not produce any noticeable injury to peach and apple foliage when applied in concentrations of 2% or lower during the summer months. The above oil in emulsified form was, therefore, employed thruout the experiment.

Spray Application

Bearing apple trees of two varieties (Wealthy and Gravenstein) were selected for this experiment. The stock oil emulsions were prepared by the aid of five per cent powdered skim milk, and were diluted to the desired concentration before used. Each of the two varieties received four different spray applications, consisting of one per cent, and half of one per cent of oil, with and without pyrethrum extract. In

order to study the effects of the two different concentrations of oil under uniform conditions the same tree was used for both treatments. One side was sprayed with 1% oil while the other side received only ½% of oil. Pyrethrum was extracted directly with the oil used from the powdered flowers and its concentration (in this particular experiment) was equal to that of one gm. of flowers to 10cc. of oil. The spray was applied by an ordinary orchard sprayer capable of developing 300 pounds pressure to the square inch. The trees were sprayed four times on the following dates: July 12, July 24, August 8, and August 24.

Experimental

1. Field Observations. Frequent observations disclosed no leaf injury, nor fruit drop in excess of that observed on the check trees. This is important because sprays with the same oil concentration applied earlier in the season resulted in appreciable fruit drop. On the other hand, the color of the leaves on the sprayed trees began to assume an increasingly darker green color after the second oil application than did the leaves on the unsprayed trees. This was especially noticeable on that side of the trees which received 1% oil regardless of whether the oil was combined with pyrethrum or not. The difference in color became so pronounced at the time of picking, especially on the Wealthy variety, that the men working around the orchard as well as visiting farmers began to inquire what was done to those trees that makes them appear greener than the other trees. In general, the foliage appeared thicker and more vigorous toward the end of the summer on the sprayed trees than on the checks. Furthermore, in the fall it was noticed that leaves remained attached to the twigs on both varieties until a later date in the season than the leaves on either the checks or the surrounding trees in the orchard. This indicates a prolonged period of vegetative growth. The entire phenomenon suggested a higher chlorophyll content in the sprayed leaves and warranted an analysis of the same.

2. Chlorophyll Analysis. Accordingly, representative samples of leaves were collected from the checks and the trees sprayed with 1% oil (without pyrethrum) from both varieties on September 9. About 50 gm. of fresh leaves were cut to narrow strips; ten gm. samples were spread on large petri dishes and dried in vacuum over H_2SO_4, in the absence of light, for several days or until the plant tissue became sufficiently brittle for grinding and subsequent chemical analysis. The dry leaves were then ground to a fine dust and 2 gm. samples were

further disintegrated with 5 gm. of pure sand by the aid of pestle and mortar. The chlorophyll was extracted by the method worked out by Willstatter (10) and modified by Schertz (9). The final determination was made by comparing the diluted extract with standard solutions prepared from pure chlorophyll[2] and calculated on the basis of fresh leaves.

From the results presented in Table 1, two facts become apparent. First, that the leaves from Gravenstein apple trees are appreciably richer in chlorophyll than those from the Wealthy variety. Second, the oil-sprayed leaves of both varieties contained a higher amount of chlorophyll than did the corresponding checks. These increases in chlorophyll amounted to 28% in the Gravenstein and 47% in the Wealthy.

TABLE 1. CHLOROPHYLL EXTRACTED FROM UNSPRAYED AND OIL-SPRAYED LEAVES

Variety of Apple Tree	Treatment	Sample of Fresh Leaves Taken for Analysis	Per cent Chlorophyll	Per cent Increase of Chlorophyll in the Oil-Sprayed Leaves
Wealthy	check (unsprayed)	4.00 gm.	0.28	47%
Wealthy	1% oil	4.16 gm.	0.41	
Gravenstein	check (unsprayed)	4.34 gm.	0.33	28%
Gravenstein	1% oil	4.26 gm.	0.42	

DISCUSSION

The physiological response of apple foliage following spraying with oil emulsion is an interesting one and leads to a problem in plant physiology which requires fundamental study. One of the main functions of plants, the building up of organic matter from inorganic substances, depends upon the green coloring of leaves. Any factor which induces higher formation or accumulation of chlorophyll is, therefore, of extreme importance in the plant economy. The following explanations are offered for the higher chlorophyll content observed.

A. The oil spray may stimulate directly chloroplast formation in the epidermal cells of the leaf. A similar phenomenon often results from Bordeaux sprays. It has been frequently mentioned in literature that plants sprayed with Bordeaux mixture are greener than unsprayed plants. Frank and Krüger (4) obtained more chlorophyll from potato leaves sprayed with Bordeaux than from the unsprayed. Rumm (8) finds more chloroplasts in grape leaves sprayed with Bordeaux than in

[2]The pure chlorophyll was obtained from Dr. Schertz, Washington, D. C.

unsprayed leaves. Zucker (11) sprayed a number of different plants and found in all cases a higher chlorophyll content where Bordeaux was applied, but not where lime alone was used. On the other hand, Butler (1) finds that tomato, radish, and bean plants sprayed with Bordeaux did not always show increased coloration.

Various theories are offered by the above authors to explain this phenomenon, such as chemotactic action of copper on the epidermis of the cell (8); direct electric stimulation of copper (11); indirect effect of the spray mixture (1) by shading etc.

B. The high reduction in numbers of red mite and the appreciable reduction of leafhoppers on the sprayed trees, as compared with those found on the unsprayed trees, with the consequent smaller amount of injury to foliage, might have allowed a higher accumulation of chlorophyll.

C. A coat of oil on the surface of the leaves may reduce the light intensity reaching the epidermis, brought about by refraction and possibly diffusion of the sun rays, and allow a higher accumulation of chlorophyll. It is a well known fact in plant physiology (6) that less chlorophyll accumulates in strong light than in weak or medium light. Formation and decomposition of chlorophyll occur simultaneously. The decomposition process is, however, very rapid in light of high intensity and nearly absent in light of low or medium intensities. Furthermore, high light intensity may, in addition to decomposing the chlorophyll already formed, also interfere with some other processes antecedent to chlorophyll formation.

The above reasons are mere assumptions which suggest themselves to explain an interesting phenomenon observed. Some of these assumptions are based on absolute scientific facts, while others require more extensive studies in plant physiology and biochemistry in order to prove or disprove them. The investigation of this problem is, therefore, being further continued both, under greenhouse and field conditions, with the hope of throwing some more light upon this mooted question.

Summary

Two varieties of apple trees received several spray applications of a highly refined lubricating oil during the months of July and August. No injury to foliage or fruit was observed from these late sprays. The leaves on these trees were darker green; appeared more vigorous; and exhibited a later leaf drop than those of either unsprayed trees or trees which received other sprays. Chemical analysis disclosed the fact that

the oil sprayed leaves of both varieties contained appreciably more chlorophyll than did the leaves from the unsprayed trees.

Acknowledgments

The author feels indebted to Dr. T. J. Headlee for suggesting this problem, and to Professor M. A. Blake for valuable advice and assistance freely given in field experiment.

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Mr. G. E. Sanders: May I ask Dr. Ginsburg if he made any studies as to the permeability of the leaves?

Mr. J. M. Ginsburg: Permeability to oil?

Mr. G. E. Sanders: Oils and other solutions.

Mr. J. M. Ginsburg: I have made some experiments on permeability of apple leaves to oils, and found that both varieties are readily permeable to oils of low viscosities and slowly permeable to oils of high viscosities. The rate of permeability, however, was more rapid in the Wealthy than in the Gravenstein.

MR. G. E. SANDERS: When we were working on the damage from sulphur, we found that some varieties were injured a great deal more by lime sulphur than others, and Mr. Kelsall who carried on the experiments in the laboratory, found that the variety that was most easily injured by land sulphur, was the Wagner. It was permeable to the salt solutions. The Golden Russet was not injured very much by land sulphur. The Gravenstein that we worked with was not easily injured by the sulphur. Here the permeable leaves gave higher benefit from the oil spray than one of lower permeability.

MR. P. J. PARROTT: I would like to ask Dr. Ginsburg if he noticed in his plat sprayed with these oils any noticeable difference between the fruits as far as coloration is concerned from trees treated with oil as compared with the fruit taken from trees not treated. Where we have made as many as three or four applications of these oils during the summer, we have noticed the darker green foliage. In the case of the Rome, we have lacked a coloration of the apple, that is, the fruit from the oil-treated tree is not as highly colored. Moreover, at the time of harvesting it has been difficult some seasons to harvest the fruit without pulling off the buds.

MR. J. M. GINSBURG: As far as I can recall, we did not see any difference in coloration of fruit on these two varieties.

PRESIDENT W. B. HERMS: The next paper is by C. O. Eddy and E. N. GEDDINGS.

DETERMINING HYDROCYANIC ACID GAS CONCENTRATION IN FUMIGATION EXPERIMENTS[1]

By C. O. EDDY and E. N. GEDDINGS, *Clemson College, S. C.*

ABSTRACT

The concentration of hydrocyanic acid gas in a large room fumigated with Cyanogas calcium cyanide was determined by removing fixed quantities of air during definite periods at selected times by an aspirator system, passing the samples through small volumes of 3.5% sodium hydroxide solutions, and calculating the ppm from analytical results secured by using a modification of the Liebig method. No consistent difference was noted in the concentration of gas at different elevations. The rate of decrease was directly proportionate to the initial concentrations. The decrease was also most clearly marked during the first five hours. Higher initial concentrations of gas per unit of calcium cyanide were derived from lower dosages. An increase in concentration usually occurred during the first two or three hours with dosages above 4 ounces per 1000 cubic feet.

[1]Contribution 25 from the South Carolina Experiment Station—December 1928.

The Object

The object of the experiments was to derive a knowledge of the concentration of hydrocyanic acid gas in a large room while fumigation experiments with Cyanogas calcium cyanide were in progress.

The Problem

The two major divisions of the problem were: First, the mechanical, involving the construction of an apparatus to remove definite quantities of air from representative places in the room at specific time intervals and to extract the hydrocyanic acid gas for quantitative determination; and, second, the chemical, involving the adoption of a method and procedure whereby the quantity of hydrocyanic acid gas could be accurately and quickly determined.

The Apparatus

The successful method adopted to remove the samples of air from the room employed an aspirator apparatus which caused air to flow from the fumigation room through two absorbing solutions of sodium hydroxide arranged in series.

Figure 13 represents the apparatus diagramatically. A graduated forty-five-liter aspirator bottle caused air to flow from a selected place in the fumigation room through two five-foot absorbing tubes twenty-three mm. and seventeen mm. in diameter, respectively, which were connected with tubing six millimeters in diameter (inside dimensions). The drain from the aspirator bottle also was six-millimeter rubber tubing and was furnished with a clamp so adjusted that the aspirator bottle was automatically emptied during a fixed period of time.

The absorbing tubes were closed at each end with one-hole rubber stoppers through which the tubing entered. At the lower end of each absorbing tube "T"-joints were used to provide a drain for the removal of solutions and for the entrance of the air from the fumigation room (see Figure 13). Glass beads to a depth of one and one-half inches were used in the bottom of the absorbing tubes.

All connections were sealed with paraffin.

It can be seen from the figure that when water was syphoned from the aspirator bottle, air flowed through the "intake tube" into the bottom of tube 1, out at the top, through the downward connecting glass tubing into the bottom of tube 2, through it and out at the top where it entered the aspirator bottle.

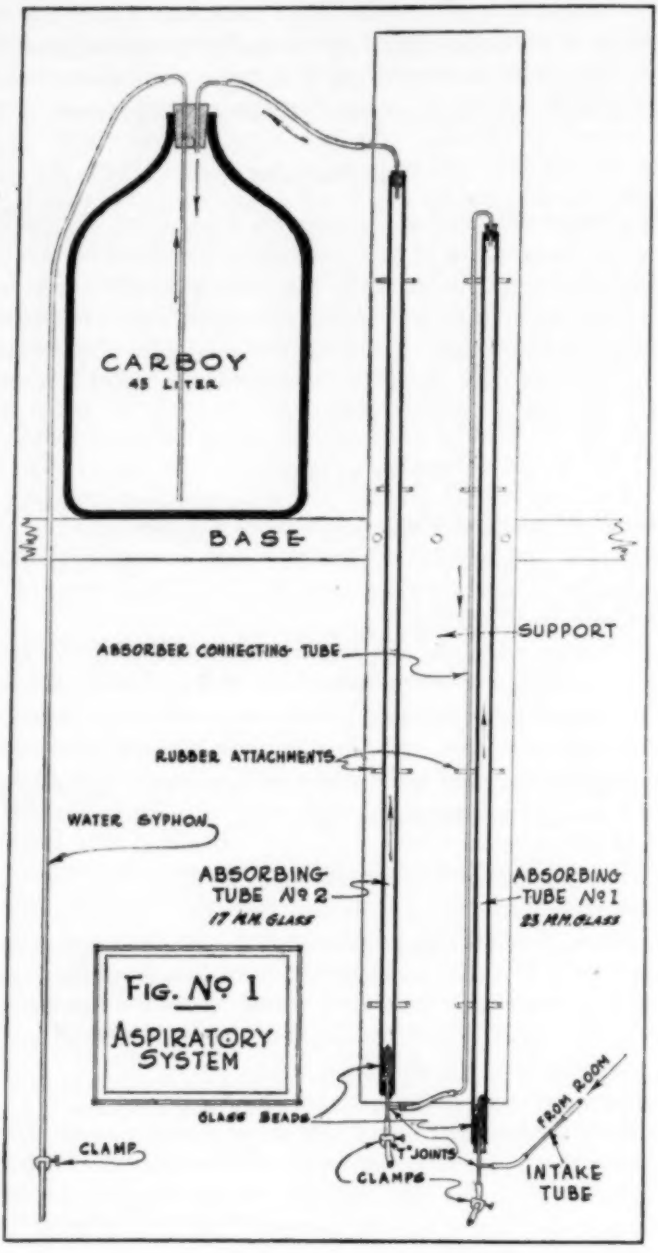


FIG. 13.—Diagram of apparatus.

The absorbing tubes 1 and 2 were arranged so that the larger was the first in the order of absorption. Complete absorption of the hydrocyanic acid gas from the air was secured by using 60 cubic centimeters of 3.5% sodium hydroxide solution in the larger and 30 in the smaller absorbing tube with dosages of 8 ounces of calcium cyanide, or less, per 1000 cubic feet. For higher dosages, 100 cubic centimeters of the same solution were required in the larger tube and 60 in the smaller to secure complete absorption.

The construction of the apparatus which met the requirements of the experiment embodied the following important features: The removal of a definite quantity of air in and at uniform time intervals, the removal of a quantity large enough to be representative of the general concentration, and the complete absorption of the hydrocyanic acid gas in a small enough quantity of absorber to give a concentration sufficiently great for accurate analysis.

The mechanical features of the apparatus which provided for complete absorption were: The small absorbing tubes which gave depth to the solution, the glass beads which broke up air bubbles and increased the surface exposure, and the constant low and uniform rate of flow of the air made possible by the adjustment of the aspirator syphon. Extremely long absorber tubes were necessary to prevent the absorbing solution from passing into the aspirator bottle.

A diminished pressure occurred in the aspirator bottle at the end of a process involving the removal of approximately 40 liters of air from the room. The lower pressure caused by the resistance of the apparatus and of the absorbing solution to the flow of the air was sufficient to cause the return of one liter of water to the aspirator bottle when a tube was led directly to it from a reservoir having the same water level. It was necessary to syphon 41 liters of water from the aspirator bottle to remove the hydrocyanic acid gas from 40 liters of air.

The Chemical Analysis

The method of determining the hydrocyanic acid content of the absorber solution was a modification of that used by Leibig.[2] The Liebig method is usually employed when the cyanide is present as a highly soluble salt in moderately concentrated solutions. In this form it is titrated with a standard silver nitrate solution, potassium iodide being used as an indicator. The first reaction upon the addition of the

[2]Scott, Wilfred W. Standard Methods of Chemical Analysis. 1927. D. Van Nostrand Co.

silver nitrate results in the formation of a complex salt, sodium silver cyanide, if sodium cyanide is the salt present. As soon as all of the sodium cyanide present has been used in forming that salt, the further addition of silver nitrate, from its reaction with potassium iodide, produces a precipitate of silver iodide. The initial appearance of the precipitate indicates the completion of the reaction with sodium cyanide.

The above process furnishes an ideal method for the determination of large quantities of hydrocyanic acid, but for extremely small quantities the silver nitrate must be greatly diluted and in this form does not give accurate results.

The turbidimetric method of determining hydrocyanic acid was suggested by the entomologists of the American Cyanamid Company. This method is based on the use of a standard silver iodide suspension, each cubic centimeter of which is equivalent to 0.054 milligrams of hydrocyanic acid. The suspension is prepared by diluting 10 cubic centimeters (accurately measured) of an exact tenth-normal silver nitrate solution with sufficient distilled water to make 400 cubic centimeters. This material is then added to 400 cubic centimeters of distilled water containing approximately 5 grams of potassium iodide. It is necessary to stir the potassium iodide solution constantly while adding the silver nitrate solution. A quantity of distilled water sufficient to make one liter is then added. In such dilute solution the reaction of silver nitrate with potassium iodide results in the formation of a colloidal suspension of silver iodide.

It was recommended that known quantities of suspension be added to a 3.5% solution of sodium hydroxide and that air containing the hydrocyanic acid gas be drawn through it. By this process the disappearance of the turbidity, characteristic of the suspension, indicates that sufficient hydrocyanic acid has been absorbed to react with all the silver iodide. The quantity of hydrocyanic acid is computed from the quantity of suspension used and the volume of air that passes through the solution.

It was found that the turbidimetric method, with the following modifications, was satisfactory. The hydrocyanic acid was absorbed in a 3.5% solution of sodium hydroxide and that solution titrated with the silver iodide suspension. Turbidity in the solution indicated the endpoint. This change in procedure was adopted because it was necessary to use the hydrocyanic acid gas from a constant volume of air for each analysis.

The following chemical equations and formulae illustrate the im-

portant chemical reactions and the computations involved in the derivation of the concentration of the gas in the fumigation room:

1. $NaOH + HCN \longrightarrow NaCN + H_2O$
2. $KI + AgNO_3 \longrightarrow KNO_3 + AgI$
3. $AgI + 2NaCN \longrightarrow Na\,Ag(CN)_2 + NaI$
4. 2HCN : AgI :: X gr. HCN : (Titer AgI × cc. used)

5. $$\text{ppm.} = \frac{0.054 \text{ mg} \times C}{L \times D}$$

0.054 = AgI titer in mg.
C = cc. AgI used
L = Liters of air
D = Density of air

The first equation represents the reaction during the process of absorption, the second the reaction in the formation of the suspension, and the third the reaction during the process of titration. The fourth item gives a proportion showing the quantitative chemical reactions from which the actual grams of hydrocyanic acid can be computed.

The relations expressed in the proportion (item 4) are obtained from equations 3 and 1. Equation 3 shows that two molecules of sodium cyanide (NaCN) are equivalent to one molecule of silver iodide (AgI). Equation 1 shows that one molecule of hydrocyanic acid (HCN) is equivalent to one molecule of sodium cyanide (NaCN). From these relations it can be seen that two molecules of hydrocyanic acid (HCN) are equivalent to one molecule of silver iodide (AgI) as stated in the proportion. The titer of the silver iodide suspension, prepared as previously described, is 0.0002348 grams. It is found by the proportion $AgNO_3$: AgI:: 0.016989×10^{-2} : X, where 0.016989 grams is the titer of an exact tenth-normal silver nitrate solution and 10^{-2} is the relation between the dilutions of the silver nitrate and the silver iodide. By substituting the titer of the silver iodide and the molecular weight of hydrocyanic acid and silver iodide in proportion 4, "X", or the hydrocyanic acid equivalent of each cubic centimeter of the suspension, namely, 0.054 milligrams, is obtained.

The quantity of hydrocyanic acid in parts per million was derived by the use of formula 5. The numerator of the fraction expresses the hydrocyanic acid in milligrams and the denominator expresses the weight of air in kilograms. Therefore, the fraction gives parts per million directly.

Two important precautions in using the above method were observed: First, the suspension was freshly prepared for each series of titrations as it agglomerated and settled when standing; and second, great care was taken to observe the first appearance of permanent turbidity as the end-point was not so pronounced as in some of the common colorimetric determinations

The Fumigation Room

The room in which all fumigations were conducted was located on the ground floor of a brick building. The length, breadth, and height of the interior were 39, 27.5, and 19.5 feet, respectively. The volume, found by subtracting the volumes of supporting columns and joists from the product of the linear measurements, was 1800 cubic feet. The walls and ceiling were covered with a smooth plaster; the floor was made of concerte.

There were six large windows on the south and the east sides, one small window and one door on the north side, and one small and one large door on the west side. The south and east sides were exterior parts of the building; the north and west sides were interior parts. The room was tightly closed during each experiment.

The Procedure

The Cyanogas calcium cyanide for each fumigation was weighed accurately, transferred immediately to the closed fumigation room, and distributed by the "dust cloud method" (South Carolina Experiment Station Bulletin 237 pp. 5–6, inclusive).

A total of seven samples of air were removed from the fumigation room by each of the three apparatus during the 24 hour exposure of each dosage. An entire procedure became known as an "experiment." The removal of each set of samples was known as a "run." The samples were taken more frequently early in the experiments when the concentrations were changing more rapidly. In the following table which shows the relative mid-point of each run, 2:30 indicates two hours and thirty minutes and refers to the period that elapsed after the distribution of the pioson. Approximately 20 minutes were required for each run.

Table 1. Relative Mid-Points of Runs

Run.....	1	2	3	4	5	6	7
Time.....	0:30	1:30	2:30	5:30	11:30	17:30	23:30

All data are recorded as if secured from the mid-point of the run.

The inlets of the intake tubes of the three apparatus were located at heights of three, ten and a half, and eighteen feet above the center of the floor. The orifices of the tubes were directed horizontally.

At the completion of a run the solutions of sodium hydroxide containing the absorbed gas were transferred from the absorbing tubes to glass beakers. To insure the removal of all the solution, the absorbing tubes and the glass tubing which came in contact with the solution

were washed with distilled water which was caught in the same beakers that contained the first solutions drained from these tubes. The solutions were analyzed at once for hydrocyanic acid.

Temperature and relative humidity were recorded at the beginning of each run.

The Data

Table 2 is constructed from typical and representative experiments by using the average concentrations of gas secured from the three apparatus. The data showed that there was no consistant difference in the concentration at the three elevations.

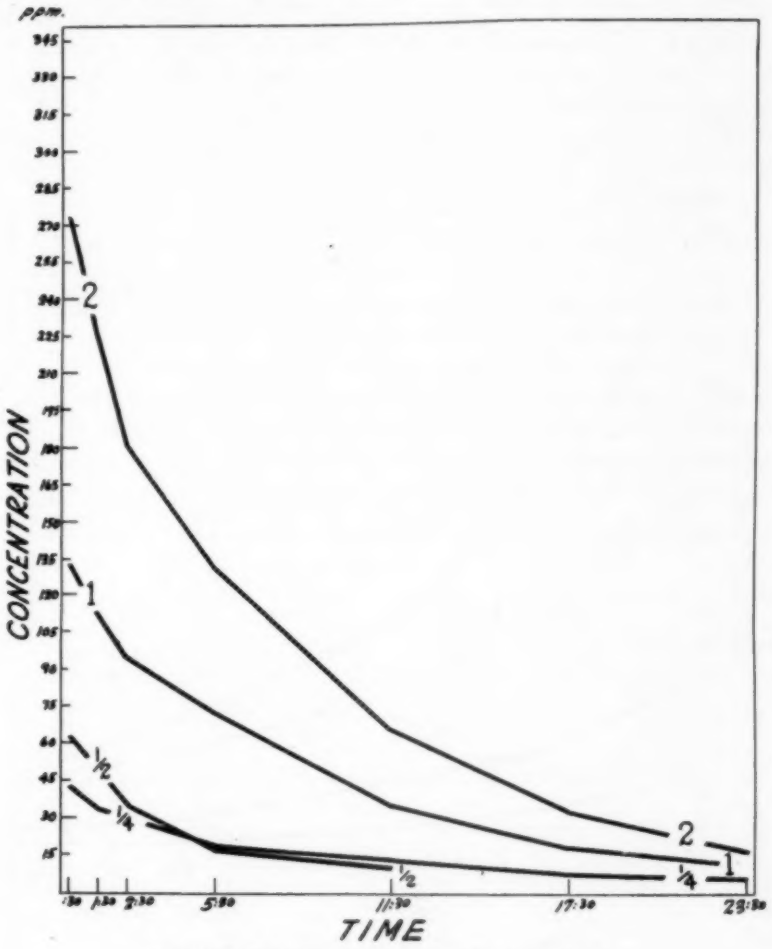


Fig. 14.—Decline of concentrations in series 1.

TABLE 2. SUMMARY OF DATA

Dosage	1/8		1/4		1/2		1		2		16
Series	1	2	1	2	1	2	1	2	1	2	1
Time											
:30	24.04	20.16	41.43	40.90	62.38	74.73	134.13	149.39	273.95	295.36	1413.07
1:30	23.96	20.99	34.60	34.43	47.76	70.89	112.31	144.10	224.33	250.40	1757.47
2:30	21.55	18.96	29.49	32.27	35.74	65.33	95.32	133.13	180.08	198.36	1796.58
5:30	17.66	14.68	19.83	24.66	18.91	46.17	73.72	101.59	131.59	150.08	1470.55
11:30	15.70	10.89	11.86	15.73	9.64	——	35.78	68.00	65.29	95.87	701.80
17:30	12.91	8.52	7.60	10.89	——	21.70	19.23	47.45	32.63	62.19	429.25
23:30	12.29	7.86	5.17	10.41	——	14.88	9.85	32.55	17.05	38.60	265.54

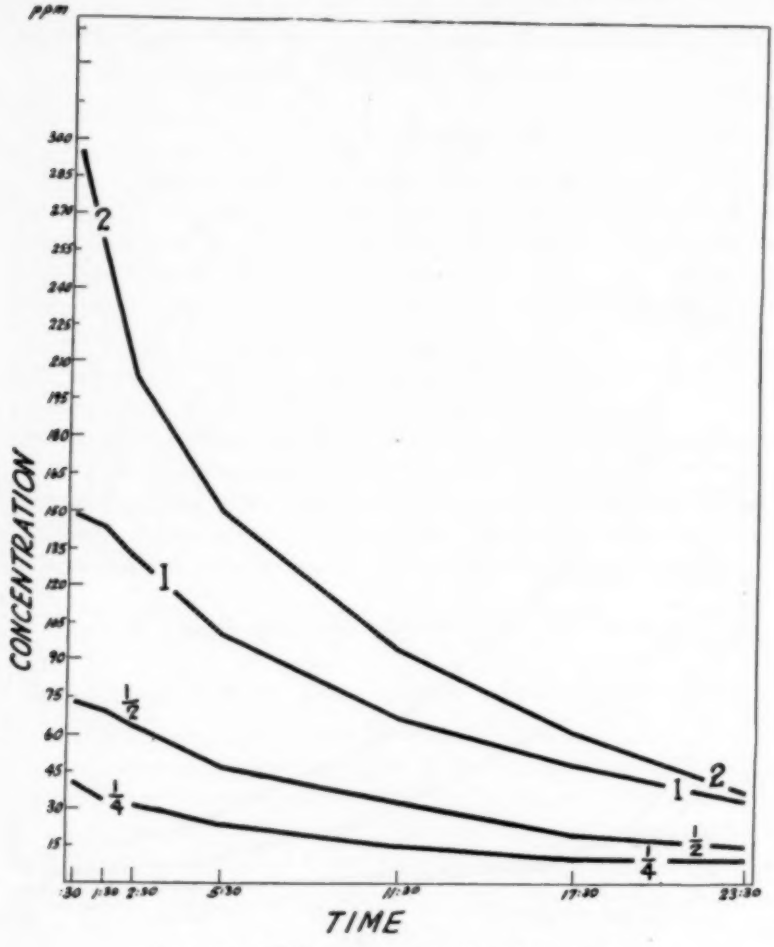


FIG. 15.—Decline of concentrations in series 2.

Data on temperature and relative humidity are omitted since they did not prove to be modifying factors. In general, temperature ranged from 75° F. to 80° F. and relative humidity from 60% to 80%.

The true relationship of the concentration of the hydrocyanic acid gas to time of exposure is shown graphically for dosages of ¼, of ½, of 1, and of 2 ounces in Figures 14 and 15. The addition of data from the other dosages would not add information, even if the higher dosages were considered. Since it would be impossible to present those higher units on a scale that would express differentiation in lower dosages, they are omitted. The data secured from the higher dosages are shown graphically in other figures.

Figures 14 and 15 show that the rate of decrease in concentration of the gas is greater for higher dosages. It was found, in general, that the rate of decrease was directly proportionate to the initial concentration. The most rapid change in concentration was most clearly marked during the first five hours, but it was noticeable throughout the course of the experiment. The rapid decline extends over a somewhat longer period with the higher concentrations, but it gradually approaches the decrease in concentration from the lower dosages.

A study of the relative concentration of hydrocyanic acid gas secured from each dosage in the two series was made by reducing the concentration of gas secured from all dosages greater than ⅛-ounce to that figure which represents the amount given off by a ⅛-ounce portion. This figure was derived by dividing the concentration secured in every instance by the numerator of that dosage when expressed in eighths. These data for representative dosages are shown in Tables 4 and 5.

TABLE 3. REDUCTION OF CONCENTRATION TO ⅛-OUNCE BASIS

Series 1.

Time	:30	1:30	2:30	5:30	11:30	17:30	23:30
Dosage				Concentration			
⅛	24.04	23.96	21.55	17.66	15.70	12.91	12.99
¼	20.72	17.30	14.74	9.92	5.93	3.80	2.58
1	16.77	14.04	11.91	9.21	4.47	2.40	1.23
16	11.04	13.73	14.03	11.48	5.48	3.35	2.07

TABLE 4. REDUCTION OF CONCENTRATION TO ⅛-OUNCE BASIS

Series 2.

Time	:30	1:30	2:30	5:30	11:30	17:30	23:30
Dosage				Concentration			
⅛	20.16	20.99	18.96	14.68	10.89	8.52	7.86
¼	20.45	17.22	16.14	12.33	7.86	5.44	5.21
1	18.67	18.01	16.64	12.69	8.50	5.93	4.07
2	18.46	15.65	12.39	9.38	5.99	3.88	2.41

The data secured from the 1/8, the 1/4, the 1, and 16 ounce dosages of series 1, when expressed as indicated above, are shown graphically in Figure 16. Figure 17 is a similar graphic representation of data secured from the three dosages 1/8-, 1/4-, and 2-ounce of series 2. The data secured from the other dosages in each series gave similar information.

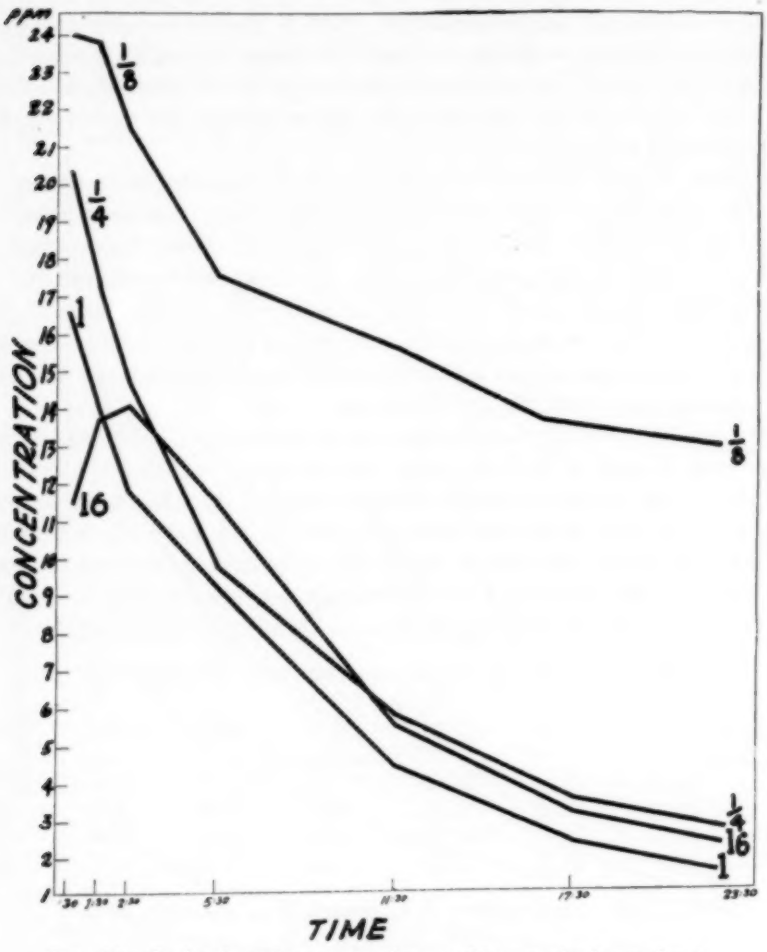


FIG. 16.—Reduction of concentrations to 1/8-ounce basis—series 1.

The curves on Figures 16 and 17 show that the higher initial concentrations per unit of calcium cyanide were derived from the lower dosages. This fact is correlated directly with the surface exposure of the dust, since the smaller dosages were more completely atomized although the

same technic of application was used. The smaller dosages also formed a thinner film on the floor. With the larger dosages, however, there was usually an increase in the concentration of gas during the first two or

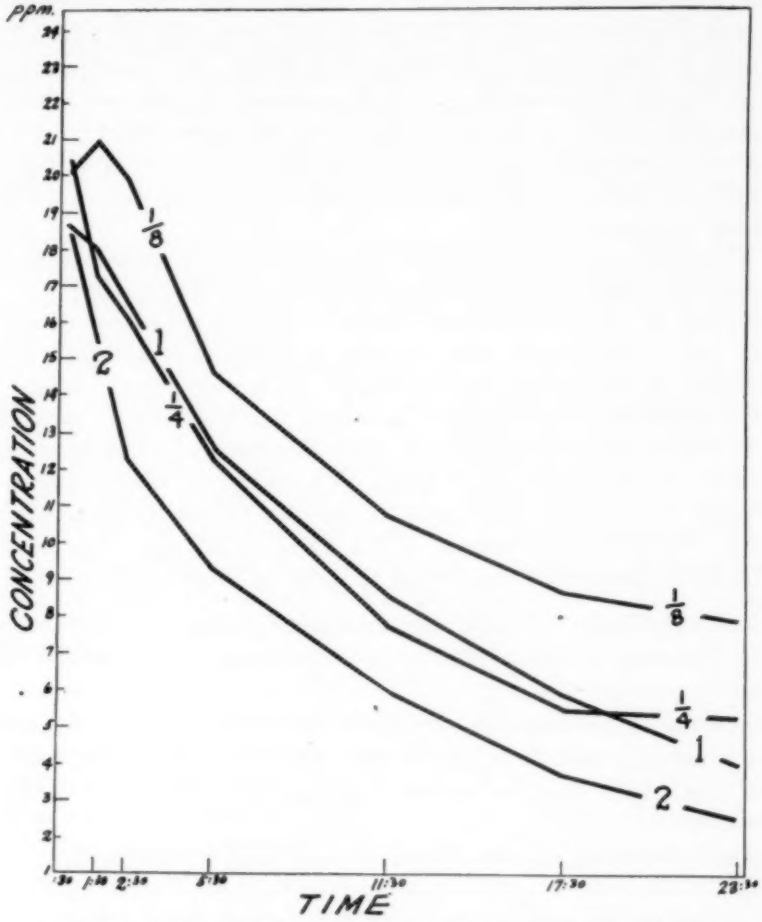


FIG. 17.—Reductions of concentrations to ⅛-ounce basis—series 2.

three runs. After the increase, a decline began that gradually approached that of the lower dosages. The curves then behave as stated above for the lower dosages.

SUMMARY

The concentration of hydrocyanic acid gas in a large room fumigated with Cyanogas calcium cyanide was determined by removing samples

of air, passing them through small volumes of absorber solution, and analyzing the absorber for hydrocyanic acid. Each one of a set of three aspirator apparatus, at selected time intervals and for definite periods, caused fixed volumes of air to flow from near the top, from the middle, and from near the bottom of the fumigation room through two 3.5% solutions of sodium hydroxide arranged in series. The concentrations were derived from the results secured by analyzing the absorber solution for hydrocyanic acid by a modification of the Liebig method.

No consistent difference was noted in the concentration of gas at different elevations in the room. Temperature and relative humidity were not modifying factors.

The data secured from the seven runs of several representative experiments are included. Some of the data are illustrated graphically.

The rate of decrease in concentration is greater for higher dosages. It was found, in general, that the rate of decrease was directly proportionate to the initial concentrations. The most rapid change in concentration was clearly marked during the first five hours of exposure, but it was noticeable throughout the experiment. The decrease extended over a somewhat longer period with the higher concentrations.

Higher initial concentrations of the gas per unit of calcium cyanide were derived from lower dosages. With larger dosages there was usually an increase in concentrations during the first two or three runs.

MR. D. H. GRANT: I would like to ask Mr. Geddings whether he tried adding gelatine to the potassium iodide silver nitrate solution as a stabilizer.

MR. E. N. GEDDINGS: No, sir; we did not try that. Under the conditions which we worked, it was all right for us to prepare the solution freshly each time, because we used such large quantities with the large apparatus.

PRESIDENT W. B. HERMS: The next paper is by R. C. Roark.

RECENT PROGRESS IN THE CHEMISTRY OF DERRIS

By R. C. ROARK, *Insecticide Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture*

ABSTRACT

The insecticidal principle of the root of *Derris elliptica* is "Rotenone," a white crystalline material, $C_{23}H_{22}O_6$, melting point 163°C., soluble in ether, acetone, and oils, but insoluble in water. It contains two methoxyl groups, and a ketone group, but its constitution is as yet unknown. It was called rotenone, from the Japanese name of the plant "Roh-ten," by Nagai, who first isolated it in 1902.

Dried Derris root contains from 0.5 to 6 per cent rotenone. Rotenone is stable in the dried root or in solution in oil, but decomposes on contact with water or alkalies. For this reason soap emulsions containing rotenone should be prepared only shortly before using. According to Japanese experimenters, rotenone decomposes within 2 days after application to foliage, and hence, vegetables sprayed with it may be subsequently eaten with impunity. In connection with a study of the constitution of rotenone, the Insecticide Division of the Bureau of Chemistry and Soils has prepared from the Derris literature about 250 abstracts, many of which are from sources not readily available. Entomologists who desire to make tests with rotenone or who are interested in the literature of Derris are invited to communicate with the Insecticide Division of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C.

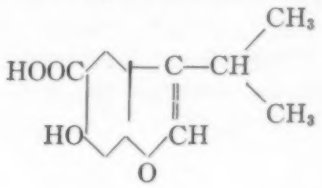
Derris elliptica has received the attention of a number of chemists, beginning with Greshoff and Wray about 1889. *Derris uliginosa* was examined in 1902 by Power, who found its constituents to be different from those of *D. elliptica*.

Apparently the first investigator to isolate the active principle in a state of purity from the root of *D. elliptica* was the Japanese chemist Nagai (J. Chem. Soc. Tokyo *23*, 740, 1902). He obtained from the root of *D. chinensis* (a variety of *elliptica*) colorless crystals containing a ketone group, melting point, 163° C. Since this plant is known in Japanese as "Roh-ten," he called the active principle "rotenone."

Several Japanese chemists have recently been studying the constitution of rotenone, particularly Takei (Bul. Inst. Phys. Chem. Research, Japan *2*, 485–496, 1923; Biochem. Z. *157*, 1–15, 1925; and Ber. *61*, 1003–1007, 1928). In Germany, Butenandt (Ann. *464*, 253–277, 1928), and in England, Wright (J. Am. Chem. Soc. *50*, 3355–60, 1928) have worked upon rotenone, and Dr. F. B. LaForge of this laboratory is now engaged in a study of this compound. The present information may be summarized as follows:

Rotenone, the active principle of the root of *D. elliptica*, is a white crystalline material, melting point 163° C., empirical formula $C_{23}H_{22}O_6$, insoluble in water, but soluble in ether, acetone, oils, and other organic solvents. A number of derivatives of rotenone have been prepared, for example, the oxime, phenylhydrazone, and hydrochloride. A ketone (CO) group and two methoxyl (OCH_3) groups are present.

By fusion of rotenone with potassium hydroxide, rotenic acid, $C_{12}H_{12}O_4$, is formed. This may have the constitution



which is an isopropyl-hydroxy-cumarone carboxylic acid in which the positions of the substituents are unknown.

As yet, too little is known of the constitution of rotenone to predict its synthesis, although this may be possible.

A good grade of dried *D. elliptica* root contains from 2½ to 6 per cent rotenone, but some samples examined in this laboratory contained less than 0.5 per cent.

According to a recent consular report (Special Circ. No. 192, Chemical Division, Bureau of Foreign and Domestic Commerce), the total production of tuba (Derris) root in Sumatra in 1928 will probably be 600,000 pounds. The consumption in Sumatra totals 32,000 pounds per annum.

The local price of Sumatra Derris root is from 16 to 20 cents per pound, but in the United States it has recently been quoted at 75 cents to $2 per pound in lots of 100 pounds. Assuming a rotenone content of 2½ per cent in the roots, this makes the cost of the active principle of Derris from $30 to $80 a pound for the American consumer.

Rotenone before extraction from the root does not appear to change on long standing, but it is sensitive to the action of water and alkalies. According to Japanese investigators, rotenone is very soluble in oils and such solutions are quite stable. Used in this way, rotenone does not lose its original toxicity for a number of years. The oil solution is emulsified with soap before being used. Experiments by Japanese scientists have shown that an emulsion of rotenone does not keep its original effectiveness longer than two days; hence, the emulsion should be prepared only a short time before using.

From the standpoint of spray residue toxicity, rotenone appears to be an ideal insecticide. The Japanese manufacturers of this rotenone-oil preparation state:

"Freshly prepared emulsion is highly toxic, but in two days, time after it has been sprayed the active principle becomes completely decomposed and inert, so that fruits and vegetables which have been sprayed with 'Neoton' when eaten by man or cattle will not have any bad effects. Neoton differs on this point from those doubtful insecticides containing such poisonous substances as lead arsenate, or nicotine."

Rotenone has been isolated in a state of high purity only recently so that no accurate figures as to its toxicity are available, but there seems to be no doubt that it is highly toxic to a variety of animals. However, in 1922, Fryer, Stenton, Tattersfield and Roach (Annals Appl. Biol. *10*, 18, 1923) showed that impure extracts of Derris were as toxic as nicotine to some caterpillars.

In toxicity to fish rotenone appears to be one of the most toxic materials known. Van Hasselt in 1911 (Proc. Sect. Sciences Royal Acad. Sci. Amsterdam, *13*, part 2, 688, 1911) found that derrid (an impure rotenone) killed minnows in as low a concentration as 1 in 10,000,000 with an exposure of 27 hours, or 1 in 1,000,000 with an exposure of 28 minutes.

MR. F. C. NELSON: I would like to ask where the samples came from.

MR. R. C. ROARK: All derris root we have purchased we bought from Winter & Company, located on Wall Street, in New York City. They are brokers. The material was all imported.

PRESIDENT W. B. HERMS: The next paper is by R. C. Roark and O. A. Nelson.

MAXIMUM WEIGHTS OF VARIOUS FUMIGANTS WHICH CAN EXIST IN VAPOR FORM IN A 1,000 CUBIC FOOT FUMIGATING CHAMBER

By R. C. ROARK and O. A. NELSON, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

ABSTRACT

Formulae are presented by means of which one can calculate the maximum number of pounds of a fumigant whether (1) a gas or (2) a liquid or solid which can exist in the vapor phase in an enclosed space of 1,000 cu. ft. at temperatures ranging from 32°F. to 122°F. under a pressure of 1 atmosphere.

Tables show the data for 26 compounds, including the commonly used fumigants such as hydrocyanic acid gas, carbon disulphide, paradichlorobenzene, naphthalene, nicotine, etc.

In fumigating operations it is obviously of considerable value to know not only the toxicity of the fumigant against certain insects but also how much of the fumigant can be vaporized in a chamber of definite size. To use dosages greatly in excess of this quantity results in waste of material with no increase in kill of insects. Examples of this are recorded in the literature. Parker (Hort. Trade Jour. No. 39, 27–28; No. 40, 27–28, 1925) used 13 ounces naphthalene per 1,000 cubic feet in greenhouse fumigation, whereas Hartzell (J. Econ. Ent. *19*, 780–86, 1926) used 1.5 ounces and obtained results as good as Parker's. The weight of naphthalene that can volatilize into 1,000 cubic feet at about 77° F. is .04 pound or .64 ounce.

The formulae given below show very nearly the theoretical quantities of different fumigants that can vaporize in a fumigating chamber of 1,000 cubic feet capacity. No consideration has been given to the

quantity of fumigant absorbed or adsorbed by the fumigating vault or the material within the chamber for the reason that this varies with different materials and different fumigants. The pressure at which fumigating operations are carried out is considered as 1 atmosphere (760 mm. of mercury) since the errors introduced because of changes in atmospheric pressure are exceeded by errors due to adsorption of fumigant within the chamber or by errors in weighing of doses. For the sake of clearness, two formulae are given, one for gases, such as carbon dioxide and ammonia, and the other for vapors. Inspection of these two forms will show that they are substantially the same and become identical when the vapor pressure of any fumigant reaches one atmosphere; in other words, at temperatures above its boiling point.

These formulae are readily developed from the well-known expression for the behavior of gases: $PV = nRT$ (1) where

P = pressures in atmospheres
V = volume in liters
R = gas constant = .08204 liter atmospheres per mol per degree
T = absolute temperature = $273 + t°$
n = weights of gas expressed in mols = $\frac{w}{M}$

where w = weight of gas in grams and
M = molecular weight

By substituting $\frac{w}{M}$ for n in equation 1 and solving for w, the expression becomes $w = \frac{PVM}{RT}$ (2). Since $P = 1$ (see above), equation (2) becomes $w = \frac{VM}{RT}$ (3). But w (grs.) x0.002205 = W (lbs.) and 1,000 cu. ft. = 28,320 liters. Substituting these values, and the numerical value for R in (3) and reducing to the simplest form, we obtain the expression $W = \frac{761.16\,M}{T\ (abs.)}$ (4) which gives the maximum weight (W) in pounds of a gas that can be contained in 1,000 cu. ft. at atmospheric pressure.

For fumigants whose boiling points are higher than the temperature at which the fumigating operation is carried on, the vapor pressure must be taken into consideration. By introducing this value $\frac{(p)}{760}$ into (2) and introducing the conversion factors given above the equation

$W = \frac{p \times 761.16\ M}{760 \times T(abs.)}$ or $\frac{p \times 1.0015}{T\ (abs.)} M$ is obtained, which in cases where extreme accuracy is not essential may be written: $W = \frac{pM}{T\ (abs.)}$ (5).

In the tables following, calculated from equation (4) and the approximate equation (5), the temperature T (abs.) has been converted into degrees Fahrenheit, since this is the system mostly used in fumigating operations.

TABLE 1. FUMIGANTS WHICH ARE GASES AT 32°F.

Temp.	Ammonia	Arsine	Carbon monoxide	Carbon dioxide
°F.	Lbs./1,000 cu. ft.	Lbs./1,000 cu. ft.	Lbs./1,000 cu. ft.	Lbs./1,000 cu. ft.
32	47.4	218.8	78.1	122.7
59	44.9	206.2	74.0	116.3
68	44.2	202.6	72.7	114.3
77	43.4	199.2	71.5	112.4
86	42.7	195.9	71.3	110.5
95	42.0	192.8	69.2	108.7
104	41.3	189.7	68.1	107.0
113	40.7	186.7	67.0	105.3
122	40.1	183.8	66.0	103.7

Temp.	Sulphur dioxide	Cyanogen chloride	Ethylene	Formaldehyde
°F.	Lbs./1,000 cu. ft.	Lbs./1,000 cu. ft.	Lbs./1,000 cu. ft.	Lbs./1,000 cu. ft.
32	178.7	171.5	72.6	83.7
59	169.4	162.5	68.8	79.4
68	166.5	159.8	67.6	78.0
77	163.7	157.9	66.5	76.7
86	161.0	154.5	65.4	75.4
95	158.4	152.0	64.3	74.2
104	155.9	149.6	63.3	73.0
113	153.4	147.2	62.3	71.9
122	151.1	145.0	61.3	70.8

TABLE 2. FUMIGANTS WHICH ARE LIQUIDS OR SOLIDS AT 32°F.

Temp.	Carbon disulphide[1]		Chloroform[2]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	127.3	35.5	61.0	26.7
59	246.0*	65.0	126.5	52.4
68	297.5	77.3	159.6	65.0
77	357.1*	91.2	199.1	79.8
86	432.7	108.7	246.0	96.9
95	518.8*	128.2	301.3	116.8
104	616.7	150.0	366.4	139.7
113	729.0*	174.5	439.0	164.8
122	760.0	179.4**	526.0	194.4

*Pressures calculated.

**Using formula for gases.

[1]Zeit. für Physik. *4*, 226 (1921); Ann. der Physik. *42*, 871 (1913).

[2]Zeit. Phys. Chem. *88*, 23 (1914); *55*, 355 (1906); Chem. Zeitung *36*, 1417 (1912).

TABLE 2.—*Continued.*

Temp.	Chloropicrin[3]		Carbon tetrachloride[4]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	5.7	3.4	32.8*	18.5
59	13.8	7.9	71.4*	38.1
68	18.3	10.3	91.0	47.8
77	23.8	13.1	114.5	59.1
86	31.1	16.9	143.1	72.7
95	40.1	21.4	176.2	88.0
104	51.1*	26.8	215.8	106.1
113	64.8*	33.5	262.5	127.0
122	81.4*	41.5	313.1	149.1

Temp.	Hydrocyanic acid[5]		Ethylene oxide[6]	
°F.	Vap. Press.*	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	264.3*	26.1	316.3	51.0
59	500.3*	46.9	760.0	116.4**
68	610.0*	56.2	760.0	114.4**
77	738.8*	66.9	760.0	112.5**
86	760.0	67.8**	760.0	110.7*
95	760.0	66.7**	760.0	108.8**
104	760.0	65.7**	760.0	107.1**
113	760.0	64.6**	760 0	105.4**
122	760.0	63.6**	760.0	103.8**

Temp.	Ethylene dichloride[7]		Tetrachloroethane[8]	
°F.	Vap. Press.*	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	23 8*	8.6	1.4*	0.9
59	49.3*	16.9	3.6*	2.1
68	62.9*	21.2	4.7*	2.7
77	79.6*	26.4	6.4*	3.6
86	100.0*	32.7	8.4*	4.7
95	124.6*	40.0	10.9*	5.9
104	154.2*	48.7	14.2	7.6
113	189.3*	54.9	18.3	9.7
122	230.0*	70.5	23.3	12.1

*Pressures calculated.

[3]J. Am. Chem. Soc. *42*, 1388, (1920).

[4]International Critical Tables, *3*.

[5]J. Am. Chem. Soc. *48*, 299, 1926.

[6]J. Am. Chem. Soc. *44*, 1709, 1922

[7]Accad. Gioenia Di Sci. Nat. Catania (4) 2, 1–43, 1890.

[8]Nelson (Results to be published).

TABLE 2.—*Continued.*

Temp.	Trichloroethylene[9]		Methyl formate[10]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	23.0*	11.1	241.1*	53.0
59	44.0*	20.1	430.7*	89.8
68	56.5*	25.3	515.8	105.7
77	73.0	32.2	614.0	123.7
86	94.0	40.8	724.8	143.6
95	118.5*	50.6	760.0	148.4**
104	149.0	62.5	760.0	146.0**
113	184.5*	76.2	760.0	143.7**
122	224.0	91.1	760.0	141.5**

Temp.	Ethyl formate[10]		Isopropyl formate[10]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu ft.
32	63.9*	17.3	42.1*	13.6
59	164.1*	42.2	89.5*	27.3
68	206.5	52.2	112.0	33.8
77	255.0	62.3	138.5	40.9
86	312.2	75.1	174.2	50.6
95	382.0	91.9	216.0	61.8
104	462.0	109.3	267.0	75.1
113	558.0	130.0	325.0	90.0
122	668.0	153.2	396.0	108.0

[9]Chem. Zeit. *36*, 1417, 1912.

[10]Ind. Eng. Chem. *20*, 1380–1384, 1928.

Temp.	Ethyl acetate[11]		Methyl monochloroacetate[10]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	24.2	7.8	1.9*	0.8
59	55.0*	17.7	4.9*	1.9
68	72.8	21.9	6.7	2.5
77	92.0	27.2	9.0	3.3
86	118.7	34.5	11.5	4.1
95	147.5*	42.2	15.2	5.4
104	186.3	52.4	20.0	7.0
113	229.5*	63.6	26.3	9.0
122	282.3	77.0	33.5	11.3

Temp.	Paradichlorobenzene[12]		Naphthalene[13]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft
32	.08	.04	.02	.01
59	.39	.2	.06	.03
68	.64	.3	.08	.035
77	1.0	.5	.10	.04
86	1.5	.7	.14	.06
95	2.3	1.1	.21	.09
104	3.4	1.6	.32	.13
113	5.1	2.4	.51	.21
122	7.4	3.4	.81	.32

[11]J. Chem. Soc. London, *101*, 81, 1912; Proc. Roy. Dub. Soc. *12*, 374, 1910.

[12]Calculated from results furnished in private communication from C. M. Smith, Food, Drug and Insecticide Administration, Washington, D. C.

[13]Trans. Chem. Soc. London, *77*, 412–13, 1900.

TABLE 2.—*Continued.*

Temp.	Camphor[13]		Nicotine[14]	
°F.	Vap. Press.	Lbs./1,000 cu. ft.	Vap. Press.	Lbs./1,000 cu. ft.
32	.06	.03		
59	.12	.06		
68	.15	.08	.08*	.04
77	.19	.10	.12*	.07
86	.26	.13	.16*	.09
95	.38	.19	.23*	.12
104	.60	.29	.30*	.16
113	.90	.43	.41*	.22
122	1.3	.61	.55*	.28

[14]Young and Nelson, Ind. Eng. Chem. *21*, No. 4, 321-2. (1929).

In practical fumigation work the space to be fumigated is not empty, but is occupied by various materials, such as wheat in a bin, clothing in a closet, rugs and tapestries in a room, or plants and moist earth in a greenhouse. These materials adsorb or absorb vapors and gases, sometimes to a very considerable extent. Coconut charcoal, for example, will absorb approximately 171 times its volume of ammonia gas at 32° F.

In fumigating an enclosed space partly occupied by various materials, it is, therefore, necessary to use more rather than less fumigant, in order to compensate for the loss by absorption. It is also necessary to use an excess of fumigant, in order to compensate for leakage which occurs in boxes, closets, rooms, bins, and greenhouses, as none of these is gastight. Furthermore, in greenhouses, where the temperature is usually higher than the surrounding outside air, a portion of the fumigant condenses on the walls and windows and is thus lost as far as killing insects on plants is concerned.

It is seldom necessary, however, to use more than a moderate excess of the theoretical quantity of fumigant which will saturate a space, in order to be assured of a maximum concentration of the fumigant.

The following problems may be readily solved by reference to the data in the tables:

Problem 1.—How much naphthalene is required to saturate the atmosphere in a chest 2 ft. x 2 ft. x 4½ ft. at 80° F.?

$$\textit{Answer}— \frac{18}{1{,}000} \times .05 = .0009 \text{ lb.} = .41 \text{ gram.}$$

Problem 2.—How much enclosed space will a moth ball saturate with the vapor of naphthalene at 77° F.?

$$\textit{Answer}— \frac{.00752}{.04} \times 1{,}000 = 188.0 \text{ cu. ft.}$$

(Average weight of one moth ball = .00752 lb. (3.41 grams).

Problem 3.—How much paradichlorobenzene is required to saturate the atmosphere in a clothes closet 6 ft. x 10 ft. x 8 ft. at 70° F

$$\textit{Answer}— \frac{480}{1{,}000} \times .3 = .144 \text{ lb.}$$

PRESIDENT W. B. HERMS: The next paper is by C. C. Hamilton.

THE GROWTH OF THE FOLIAGE AND FRUIT OF THE APPLE IN RELATION TO THE MAINTENANCE OF A SPRAY COATING[1]

By CLYDE C. HAMILTON, M.S., *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

The writer has spent part of his time during three summers investigating the problem presented here. The data presented in this paper covers the last year's work. Methods are presented whereby the increase in leaf area of leaves on the trees was obtained at weekly intervals and methods for collecting and determining the quantity of arsenic trioxide upon large samples of foliage and fruit collected at weekly intervals throughout the growing season. The paper then discusses the relation of the increase in size of the foliage and of the apples and the quantity of arsenic trioxide upon the leaves and the apples as indicated by data taken at approximately weekly intervals. The data shows that during the active growing season much of the reduction in arsenic trioxide per unit area is due to increase in leaf growth. During the period extending from about July 10, at which time most of the leaf growth had occurred, until September 14, when the experiment was discontinued, there was a reduction of approximately 66 per cent of the arsenic trioxide upon the leaves. Most of this loss was due to weathering. The increase in diameter of the apples occurred at a fairly uniform and even rate from the beginning of growth to September 14. The increase in surface area of the apples was more rapid as the season advanced and the increase in volume of the apples still more rapid. The reduction in the quantity of arsenic trioxide per unit area of apple or per pound of fruit from June 29, when the last spray was applied, to September 14th, was mostly due to increase in growth. The loss of arsenic trioxide on the apples due to weathering was proportionally much smaller than that which occurred on the foliage.

Considerable research has been carried on within the last several years relating to the quantity of arsenic upon apples at the time of picking the fruit. This work has considered several factors such as the different methods of applying the arsenical spray, different amounts of spray material applied, the location of the fruit upon the tree, different times of picking and the relation of rainfall. As far as the writer is aware there has been no data published, except one small paper by the

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

writer himself, taking into consideration the relation of growth of the foliage and the fruit to the quantity of arsenic maintained thereon.

The problem dealing with the relation of foliage growth and arsenic was started the spring of 1925 and carried on during the growing seasons of 1926 and 1927. That part dealing with the apple growth and the arsenic upon them, was done during the season of 1927. All of the work except that done in 1925 was carried on at the College orchard of the New Jersey Agricultural Experiment Station. The spray materials consisted of those used in the regular spray schedule applied to control insects and fungus diseases. They are as follows:

March 28. A dormant oil spray.
April 4. Delayed dormant. Lime sulfur 1 to 9 plus 40% nicotine sulfate, 1 to 500.
April 27. Pink bud. Lime sulfur, 1 to 40 plus lead arsenate 1½ to 50.
May 12. Petal fall. N. J. dry mix 8–4–50 plus lead arsenate 1½ to 50.
May 23. Seven day spray. The same as for the petal fall.
June 4. Seventeen day spray. This spray was not applied on the trees used in this work.
June 15. 40% nicotine sulfate, 1 to 600 and casein spreader (Kayso) 1 to 100.
June 29. Lead arsenate, 1½ to 50 plus casein spreader 1 to 100.

The growth of leaves upon the trees was obtained by tagging a number of twigs just as growth started in the spring. These twigs were distributed throughout different parts of the trees and an effort was made to select leaf spurs, fruit spurs, short lateral twigs and terminal twigs in about the same proportion as they occurred on the tree so as to obtain a representative growth. As soon as leaf growth started or when the first leaves unrolled, the length of the leaves from the tip to the base where the leaf petiole was attached to the leaf, and its width in the middle was measured in tenths of inches. These measurements were taken for each leaf on all the tagged twigs as long as the leaves continued to grow. A record was also kept of the length of the twigs in inches and the number of leaves at each date of measurement. Data upon the growth of the leaves, as well as upon the apple growth, was taken at as near weekly intervals as other work and weather conditions would permit.

The number of square inches of leaves upon the tagged twigs was obtained for each date of measurement by multiplying the product of the length and the width of each leaf by a predetermined factor. This factor was 0.709 for the Baldwin leaves and 0.661 for the Grimes Golden leaves. These factors were determined by collecting entire twigs with the leaves upon them at each date of leaf measurement. They were

brought to the laboratory, pressed, dried and the length and width of each leaf determined. These were multiplied together, and their products added. This sum was then divided by the total number of square inches in the leaves, which had been determined by planimeter measurements. The extreme variation during the season for the average factor of 0.709 for the Baldwin leaves was 0.07 or less than 10 per cent and the extreme variation for the average factor of 0.661 for the Grimes Golden leaves was 0.031 or approximately 5 per cent.

The apple growth was obtained by measuring the diameter, in tenths of inches, of tagged apples at the same dates when measurements were made of leaf growth. For the sake of convenience in obtaining the surface area and the volume of the apples they were assumed to be spheres, the depression at the stem end and the calyx end, being almost sufficient to round out the apple. While there is undoubtedly a noticeable error in obtaining the volume of the apples upon the trees from their diameter measurements, this error will uniformly be on the minus side. When these volumes, however, are changed into per cents of total growth this error will mostly disappear. The error involved here will not seriously effect the results since the object is to compare the data for one date with the data of another date.

Samples of foliage for the purpose of making analyses to determine the quantity of arsenic on the leaves were obtained by collecting entire twigs of all kinds, such as leaf spurs, fruit spurs, short side twigs and terminal twigs, in paper bags. These were carried back to the laboratory, the leaves stripped from the twigs, replaced in the paper bags and allowed to dry. After the leaves had dried they were weighed and multiplied by a predetermined factor to obtain the number of square inches of leaf. The leaves were then ground in a mill, thoroughly mixed, and the milligrams of arsenic per gram dry weight of the sample was determined by the modified Geutzeit method.

The factor for obtaining the area of leaves from their dry weight was obtained by dividing the leaf area of planimetered leaves (which had previously been determined in obtaining the factor for securing area from length and width measurements) by their dry weight. These constants varied throughout the growing season and for the Baldwin leaves ranged from 15.8 to 27.3 while the Grimes Golden leaves varied from 18.1 to 24.5. These variations were definite and seemed to be dependent upon the development of the leaves, therefore the constant as determined for each date of collecting leaves was used in determining the leaf area of leaves collected on that particular date.

Apples, for the purpose of making analyses to determine the quantity of arsenic they contained, were collected at the same time the leaf samples were collected. They were taken to the laboratory, the diameter of each apple recorded, and the total green weight for all the apples. The apples in the first collections, or until they grew to be about 1½ inches in diameter, were dried whole. Later apples were peeled by a machine, the peeling and calyx end being kept separate, and the peelings and calyx ends dried. Analyses were made to determine the milligrams of arsenic per gram dry weight of sample and from this data the quantity per green weight and surface area was computed.

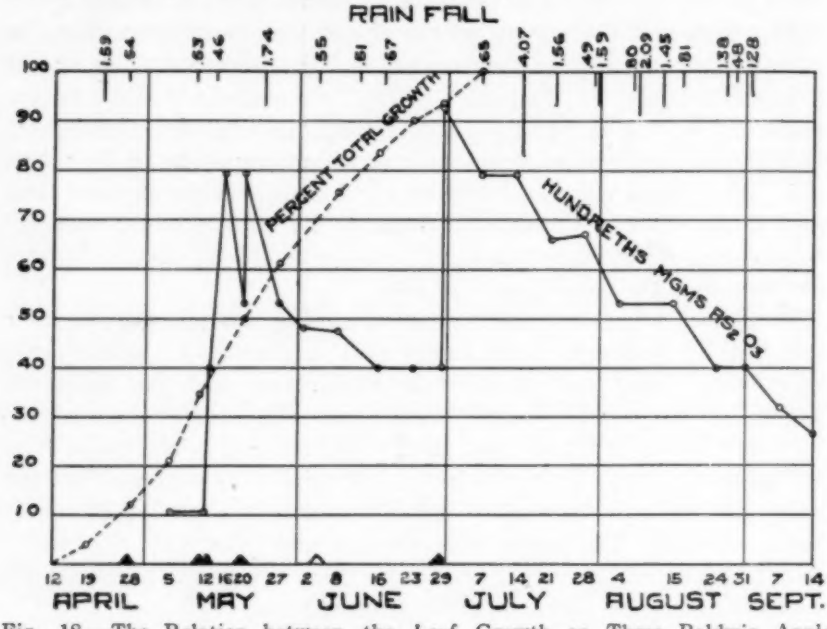


Fig. 18.—The Relation between the Leaf Growth on Three Baldwin Apple Trees and the Arsenic Trioxide per 10 Square Inches of Leaf. College Farm, New Brunswick, N. J. 1927.

All analyses of arsenic for the data in this paper were made by the modified Geutzeit method in the laboratory of Dr. H. S. McLean of the Experiment Station staff, who is devoting his time to a study of the arsenical residue upon sprayed fruit.

The tables giving the data for the charts presented in this paper are rather large and numerous, and since it is expected to publish them shortly in bulletin form they have been omitted here.

Figure 18 shows the data obtained from three Baldwin apple trees. The dates of spraying are indicated by the peak of the small solid

triangles at the bottom of the chart. Rainfall for each date is indicated by the small numbers at the top of the cart. Other data is given on the chart.

Figure 19 gives data for three Grimes Golden apple trees, similar to that shown in chart number I for the three Baldwin apple trees.

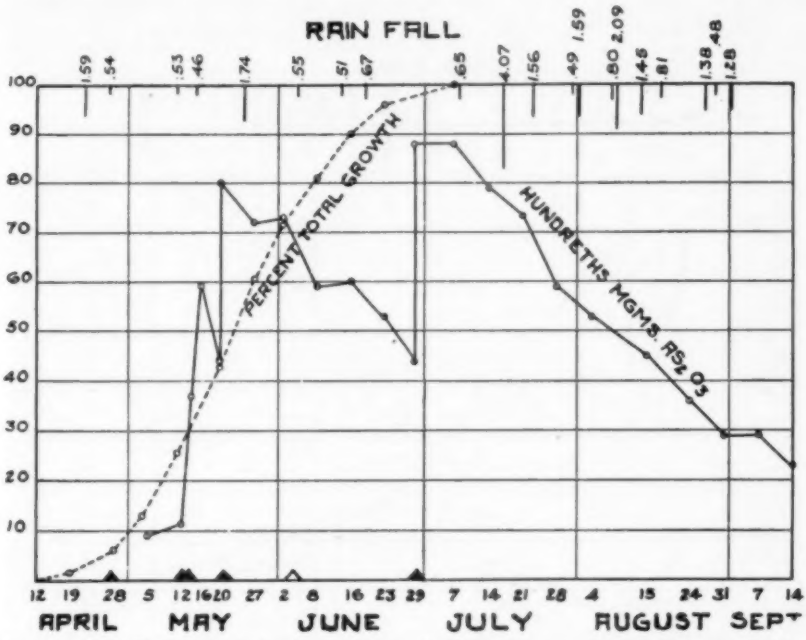


Fig. 19.—The Relation between the Leaf Growth on Three Grimes Golden Apple Trees and the Arsenic Trioxide per 10 Square Inches of Leaf. College Farm, New Brunswick, N. J. 1927.

It will be noticed that almost 40% of the total leaf area for the Baldwin apple trees was out, and 30% of the total leaf area for the Grimes Golden apple trees was out, when the calyx cup spray was applied on May 12 and the 13. The charts also show that the leaf growth increased very rapidly during the period from the calyx cup spray to the 17 day spray (which was not applied but which is indicated as June 4 by the light triangle) and that practically all the leaf growth had ceased by the time the last spray was applied on June 29th. The Baldwin apple trees started some secondary leaf growth about the last of June. Leaf area measurements were not continued after July 7, however.

The solid lines representing the arsenic trioxide per 10 square inches of leaf show a rapid rise in quantity after each spraying followed by a

rapid decrease. The decrease in arsenic trioxide is very noticeable following the calyx cup spray and seven day spray, probably influenced to a considerable extent by the rapid increase in leaf area. The decrease in quantity of arsenic trioxide after the last spray, applied June 29th and which was after most of the leaf growth had occurred, is rather uniform and regular. During a period of two and one-half months there was a falling off of approximately 66% of the arsenic trioxide upon the foliage. This is due mainly to weather conditions rather than

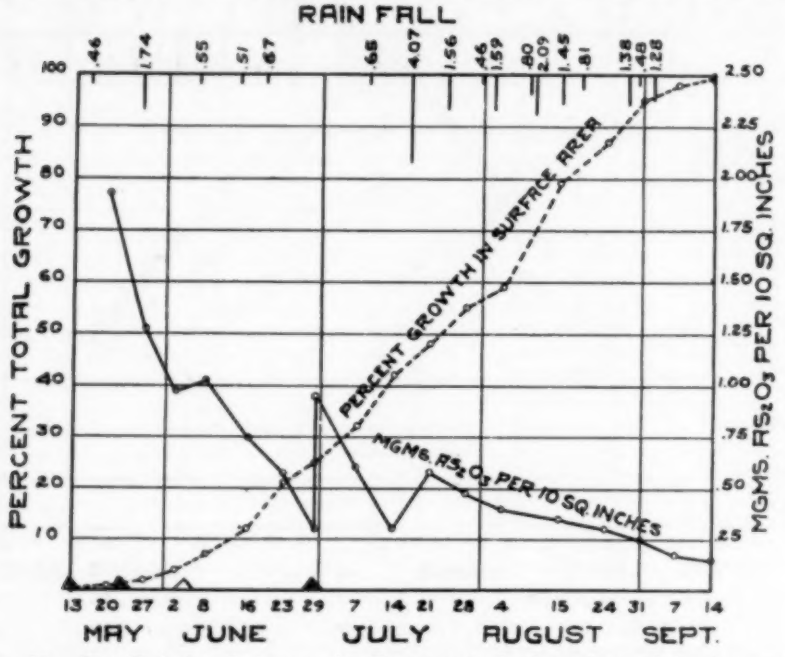


Fig. 20.—The Relation between the Increase in Surface Area of Apples upon Three Baldwin Apple Trees and the Arsenic Trioxide per 10 Square Inches of Apple Surface. College Farm, New Brunswick, N. J. 1927.

increase in leaf area since practically all the leaf growth had occurred by the end of June. A study of the rainfall did not indicate much influence upon the quantity of arsenic trioxide remaining upon the foliage.

Figures 20 and 22 show the data obtained, for the apple growth and arsenic trioxide upon the apples, from three Baldwin apple trees. The dates of spraying are shown by the peak of the small solid triangles at the bottom of the chart and the amount of rainfall by the small numbers at the top of the chart. Other data is indicated on the chart.

Figures 21 and 23 give the data for three Grimes Golden apple trees similar to that shown in Figures 20 and 22 for the Baldwin apple trees.

Figures 20 and 21 show the relation of the increase in the surface area of the apples to the milligrams of arsenic trioxide per ten square inches of surface. The two charts are similar in their general aspects and can be discussed together. They show that the quantity of arsenical residue upon the fruit per unit of area is quite large when the fruit is small as is indicated by the data obtained after sprays applied on

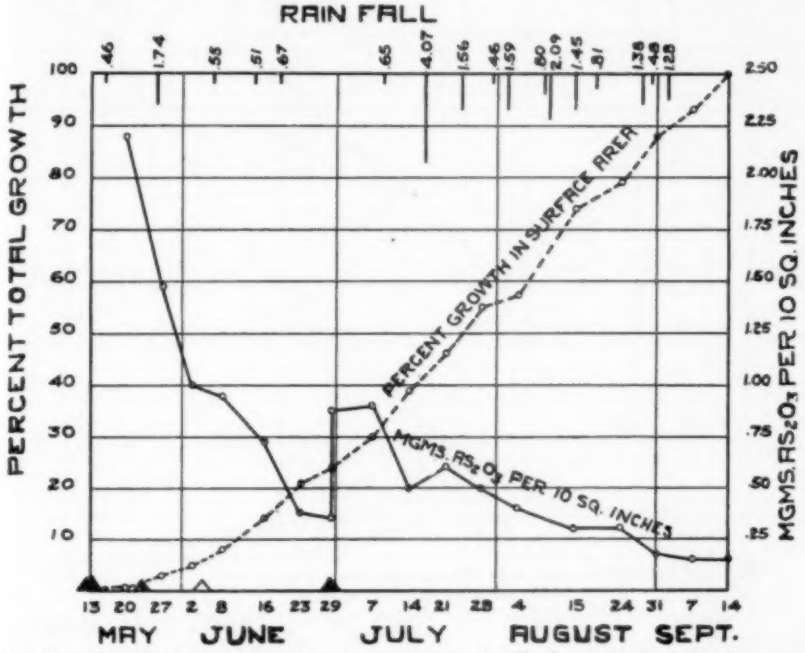


Fig. 21.—The Relation between the Increase in Surface Area of Apples upon Three Grimes Golden Apple Trees and the Arsenic Trioxide per 10 Square Inches of Apple Surface. College Farm, New Brunswick, N. J. 1927.

the 13 and 23 of May. From May 20 to June 29 the quantity of arsenic trioxide was reduced 0.65 mgms. or 84.4 per cent for the Baldwin apples and 0.74 mgms. or 84.0 per cent for the Grimes Golden apples. During the same time the surface area of the apples increased from 1 per cent of the total on May 20 to 25 per cent of the total on June 29, or approximately 25 times. It is therefore evident that the most of the loss in arsenic trioxide per unit area is due to increase in size or stretching of the surface due to growth.

The quantity of arsenic trioxide upon the surface of the Baldwin apples was increased on June 29 from .30 mgms. per 10 square inches before spraying to .95 mgms. per 10 square inches after spraying or an increase of 3.1 times. The Grimes Golden apples showed an increase from .35 mgms. per 10 square inches to .87 mgms. or an increase of 2.5 times. No sprays were applied after June 29.

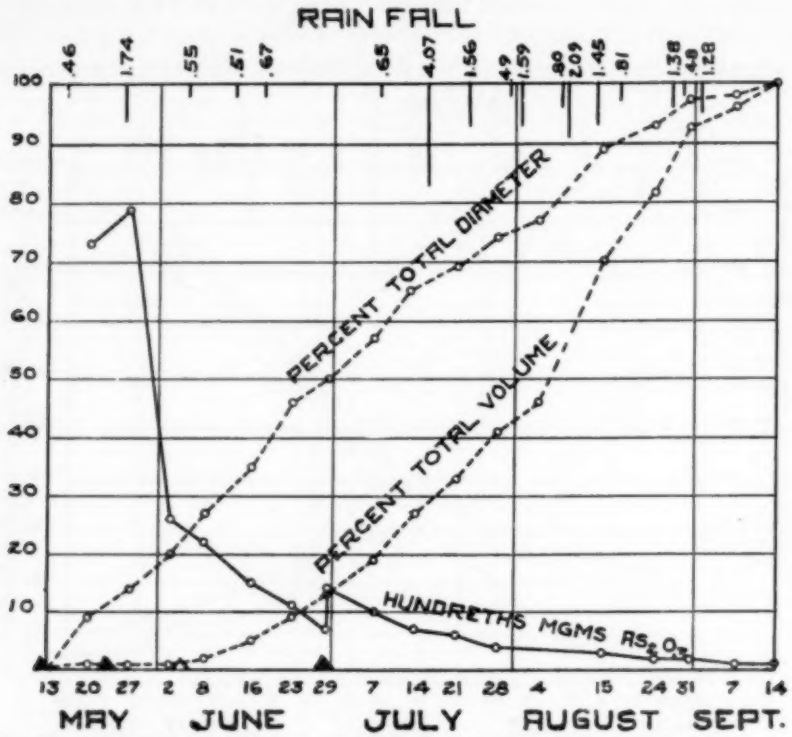


Fig. 22.—The Relation between the Growth in Diameter and in Volume of Apples upon Three Baldwin Apple Trees and the Arsenic Trioxide per Pound of Green Fruit. College Farm, New Brunswick, N. J. 1927.

Approximately 25 per cent of the total surface area of the Baldwin apples and the Grimes Golden apples had developed by June 29. From June 29 to September 14 there was a gradual reduction in the quantity of arsenic trioxide per 10 square inches for the Baldwin apples from .95 mgms. to .175 mgms. and from .875 mgms. to .175 mgms. for the Grimes Golden apples. During this same period the surface area for both varieties of apples had increased three times and the normal reduction in the quantity of arsenic trioxide per 10 square inches due

to this increase would be to one-third the original amount or to .31 mgms. for the Baldwin apples and .29 mgms. for the Grimes Golden apples. The difference between these amounts and the amounts actually found upon the apples was, for the Baldwin apples, .14 mgms. or 14.7 per cent and for the Grimes Golden .12 or 13.4 per cent. These per cents represent the amounts lost due, not to increase in size but to weathering conditions.

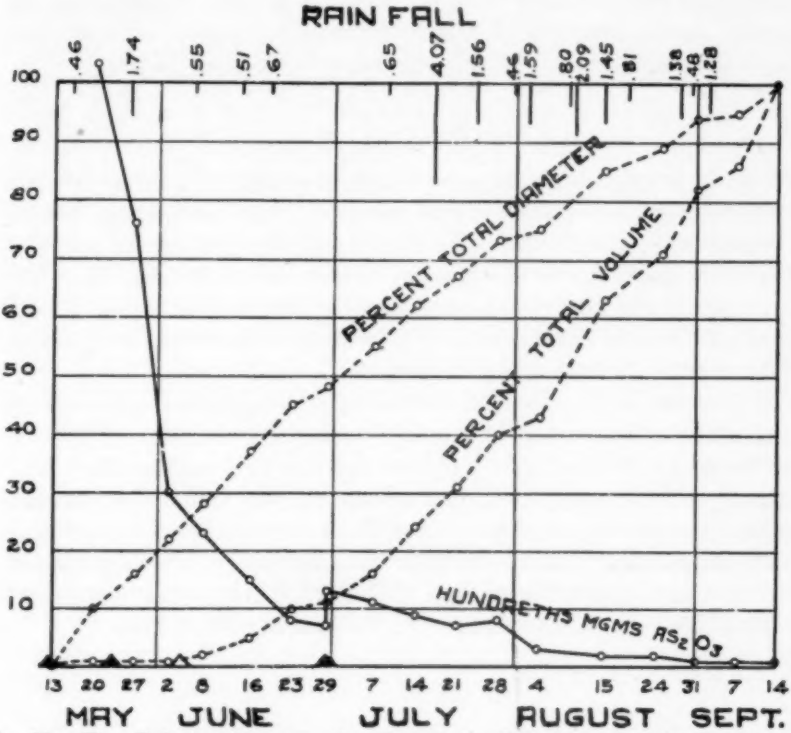


Fig 23.—The Relation between the Growth in Diameter and in Volume of Apples upon Three Grimes Golden Apple Trees and the Arsenic Trixoide per Pound of Green Fruit. College Farm, New Brunswick, N. J. 1927.

Figures 22 and 23 show the relation existing between the increase in the volume of the apples upon Baldwin apple trees and upon Grimes Golden apple trees and the mgms. of arsenic trioxide per pound of fruit. These two charts are quite similar to each other and in many respects resemble Figures 20 and 21. The quantity of arsenic trioxide per pound of fruit is very high after the sprays applied on May 13 and 23. This is probably due to the fact that the smaller the apples the larger the surface area per pound of fruit. The reduction of arsenic trioxide from May 20 to June 29 is principally due to the increase in volume of

the apples. After spraying on June 29 the quantity of arsenic trioxide per pound of fruit is doubled for both the Baldwin and the Grimes Golden apples.

On June 29, 13 per cent of the total volume of the Baldwin apples had developed or an increase of 7.7 times by September 14, while 11 per cent of the total volume of the Grimes Golden apples had developed or an increase by September 14 of 9 times. It is thus evident that the reduction in the quantity of arsenic trioxide per pound of fruit from June 29 to September 14 is principally due to increase in volume.

Summary

The data presented in this paper shows that there is a direct relation existing between the increase in leaf area and the decrease in the arsenical residue upon the leaves. The rapidity of the decrease in arsenical residue is proportional to the rapidity of increase in the leaf area. The greater part of the foliage had developed by the time the last spray was applied on June 29, therefore the loss in arsenical residue after June 29 was due mostly to weathering conditions.

The decrease in the arsenical residue upon the apples is also directly proportional to the increase in surface or volume growth.

It should be noticed that on June 29, the date of the last spray, practically all the leaf growth had developed, and that the apples had developed practically ½ their final diameter size, ¼ of their final surface area, and 1/7 to 1/9 of their final volume. It is thus evident that any sprays applied previous to the first of July would not greatly influence the final amount found upon the fruit at picking time.

Adjournment 4:10 p. m.

Monday Morning Session, December 31, 1928

The meeting convened at 9:45, President W. B. Herms in theChair.

President W. B. Herms: The first paper this morning is by H. L. Gui.

NOTES ON THE POTATO SCAB-GNAT, *PNYXIA SCABIEI* (HOP.)

By HARRY L. GUI, *Assistant Entomologist, Ohio Agri. Exp. Station*

ABSTRACT

This paper contains a discussion of the potato scab-gnat based upon observations made since 1926. Some of the results of experimental work conducted on this insect are included.

The first report of injury to potatoes which may have been done by the potato scab-gnat, *Pnyxia scabiei* (Hop.), was made by Walsh (1) in 1867. In 1895 Hopkins (2, 3, 4) published three papers on the insect describing it, establishing it as a pest, discussing its activities and making recommendations for its control. Gossard (6) in 1911 referred to it and Speyer (8) in 1923 reported it as a pest of cucumbers under glass in England. The known distribution of the insect is as follows: West Virginia (2), Missouri (5), New York (7), Pennsylvania (7), Ohio (6), Michigan, Illinois, England (8) and probably Delaware (1).

The writer's connection with the problem began in 1926 when an outbreak of the insect occurred on seed potatoes in west-central Ohio. Surveys of 1926, 1927 and 1928 showed that 6, 3 and 4.5 per cent of all the potatoes grown in central and northern Ohio were injured. Wire worms during the three years injured 15, 12 and 9.8 per cent and white grubs 2, 2, and .45 per cent, respectively.

Injury by the potato scab-gnat is of two distinct forms—that of the seed piece and of the growing tubers. Where the injury to the seed piece is severe, the entire fleshy part may be consumed and following such injury a plant cannot develop. The formation of sprout tubers occurred at the tips of the sprouts from many of the injured seed pieces. On one occasion these types of injury were observed to reduce the stand at least 25 per cent. If but a part of the seed piece is destroyed the resulting plant is greatly weakened and the yields are consequently reduced.

Damage caused by the insect to growing or mature tubers is characterized by wounds bordered with a margin of dead skin and filled with a brownish refuse having a fibrous appearance. The refuse and the healthy part of the tuber blend into one another without distinct demarcation. These wounds may be of a surface character or may penetrate to a depth of an inch or more. The larvae if present will be found near the uninjured tissues.

Injuries caused by the potato scab-gnat may in their early stages bear a superficial resemblance to common scab, and in fact are frequently mistaken for such. Potato scab, however, attacks only the

corky skin, seldom penetrating into the flesh of the tuber which is protected by the formation of a layer of cork. The lesions are surrounded by roughened areas of skin which separate them from the healthy tissue. In scab-gnat injury this roughened area and corky layer are wanting and the wounds are deeper.

In its more advanced stages, work by scab-gnat may easily be mistaken for that of wireworms feeding near the surface of the tuber.

A study of the relationship of scab-gnat damage and soil acidity made in 1927 was barely indicative that soil having a high pH value was inducive to injury. The results obtained in 1928 when a more satisfactory series of plots was studied show conclusively that a distinct relation exists, thus agreeing with Hopkins' earlier observations on this point. More injury occurred in plots having a pH value of five or above than in those having a lower value.

It has also been observed that a distinct correlation exists between the organic content of the soil and scab-gnat damage. More injury occurred to potatoes grown in soil to which no organic matter had been applied for three years previous to its use for potatoes and the least where a straw mulch was substituted for surface cultivation. An intermediate amount of injury occurred where ten tons of barnyard manure per acre was applied before the ground was plowed in the spring. These results and other observations indicate that the potato scab-gnat prefers other organic matter in the soil to growing potatoes and is more likely to attack healthy tubers when other food is not readily available.

Potatoes grown under irrigation have been injured to a lesser degree than those grown without irrigation. This supports Speyer's (8) theory that the scab-gnat attacks plants when the soil moisture is low. Plants are able to extract water from a relatively dry soil and store it up in their tissues, from which the larvae are able to obtain it in quantities sufficient to carry on their activities.

In summarizing, one may say that the potato scab-gnat may become sufficiently numerous on the seed piece in the spring to materially reduce the stand and the yield. It may also attack the crop during the growing season and impair its market value.

Ecological factors favorable for common potato scab, such as soils having a high pH value, a low organic matter and moisture content, are inducive to injury by the potato scab-gnat. These facts may make it desirable for the grower to derive his soil organic matter and nitrogenous fertilizers from sources other than the legumes which grow only in soils having a high pH value. Losses from the potato scab-gnat may be reduced by growing potatoes in acid soils with a high organic content.

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PRESIDENT W. B. HERMS: The next paper is by D. E. Fink.

A STUDY OF THE DIGESTIVE ENZYMES OF THE POTATO BEETLE AT VARIED pH

By D. E. FINK, *Philadelphia, Pa.*

(Withdrawn for publication elsewhere)

MR. J. M. GINSBURG: I would like to ask how long did the enzymes remain active under the toluene.

MR. D. E. FINK: For over a month in my experiments I have found that if the solution is covered with toluene, they can remain for six months or longer without deterioration.

MR. F. L. CAMPBELL: I would like to ask Dr. Fink if there is a salivary secretion in the potato beetle. Are salivary glands present?

MR. D. E. FINK: None were found. I do not think that salivary glands are present.

PRESIDENT W. B. HERMS: The next paper is by L. M. Peairs.

MEXICAN BEAN BEETLE

By L. M. PEAIRS, *Morgantown, W. Va.*

(Paper not received by editor)

MR. O. E. GAHM: Was any injury received from the fluosilicates to the foliage?

MR. L. M. PEAIRS: The sodium fluosilicate compound which gave best control showed no burning of foliage when used with lime at the rate of one part in three. When used undiluted, there was usually some burning.

PRESIDENT W. B. HERMS: The next paper is by Hugh Glasgow and H. J. Cook.

ONION MAGGOT CONTROL

By HUGH GLASGOW and H. J. COOK, *Ithaca, N. Y.*

(Paper not received by editor)

MR. W. P. FLINT: I might just add that in connection with the work which we have been carrying on in spraying onions for maggot control, we have found the application of the home-made oil emulsion adds considerable to the keeping qualities of the onions. That is likely true in growing onion sets from seed.

PRESIDENT W. B. HERMS: The next paper is by H. F. Wilson and Warren Whitcomb. Jr.

THE STATUS OF THE ONION MAGGOT (*HYLEMYIA ANTIQUA* MEIG.) IN WISCONSIN

By H. F. WILSON and WARREN WHITCOMB, JR.

ABSTRACT

The onion maggot is a serious pest, particularly to sets. The insect winters mostly in the puparium, though some flies hibernate. There are observations on the seasonal life history of the insect and brief notes on other troubles.

Authentic reports, as indicated on the accompanying map, show that the onion maggot is widely distributed in Wisconsin, and that it is gradually becoming more destructive with more widely distributed and more intensive plantings. It is even now quite difficult to grow garden plantings of onions, and our commercial growers are viewing the situation with alarm. This is particularly true in the two main commercial districts, one is located in Brown County at the head of Green Bay, and the other in Racine and Kenosha Counties over an area extending almost from Kenosha to Racine.

There are no records available to show just how early the serious damage from onion maggots began to appear, but in 1915 H. H. C. Severin and H. C. Severin reported in the JOURNAL OF ECONOMIC ENTOMOLOGY, Volume 8, pages 342 to 350 that some of the onion growers, and this referred to commercial growers, had been compelled to quit growing onions. The report at that time showed the importance of the pest, and in their efforts to find successful control measures, they tried out poison baits with some encouraging results. But, unfortunately, no trials were made against the first brood in the early spring, and the results were not successful. N. F. Howard, of the Bureau of Entomology, working in cooperation with the Wisconsin Agricultural

Experiment Station, made more thorough tests with the poison bait as is reported in the JOURNAL OF ECONOMIC ENTOMOLOGY, 1918, Volume 11, pages 82 to 87, and he came to the conclusion that poison baits were not satisfactory because of adverse climatic conditions. Since that time, further efforts have been made to find a satisfactory control, and a series of experiments were conducted by Mr. J. E. Dudley and his assistants, not only with baits, but they also have tried trap crops in the form of cull onions planted early in the spring to attract the egg laying females before the young sets were above ground. More or less encouraging results have been secured from these experiments, but Mr. Dudley reports that the data did not seem conclusive and that recommendations could not be given until more tests were made. It is extremely unfortunate that during this time sufficient funds were not available for a more intensive study for the damage has continued to increase without satisfactory methods of control being available.

It is entirely possible that the use of corrosive sublimate solution and Bordeaux oil as reported by Flint and Compton and used by them in the onion growing district of Cook County, Chicago, might prove entirely successful. But it will be difficult to educate our growers to the use of an extended treatment program when they already must weed from four to eight times per season and with the spray schedule would find their labor problem still more complicated. However, the situation is becoming more difficult and an important change is taking place in the Racine and Kenosha district, due to more intensive plantings. With more intensive plantings, the maggot injury increases, and, although the growers in the Racine and Kenosha district have been able to secure fair returns in spite of the maggot losses, they all realize that they are facing a more serious problem. As a result of these conditions, the growers of the Racine and Kenosha district appeared before the State Legislature in 1927 and made a request for a special appropriation to establish a laboratory in their district for the study of the onion maggot. The appropriation was made available on July 1, 1927, and a laboratory was immediately established with Mr. Warren Whitcomb, Jr., as the active field agent. The observations of previous workers in both the Green Bay and Kenosha-Racine districts indicated the need of making a thorough and detailed study of soil types, climatic conditions, life history, and behavior of the onion maggot in relation to possible satisfactory methods of control.

The Racine-Kenosha District

This onion growing section extends northward and southward for about ten miles along Lake Michigan and westward for a distance of one to four miles from the Lake Shore. The entire area is a truck crop district devoted to onions, cabbage, potatoes and beets. Of these crops, onions are first, both in value and acreage. The soil types are generally clyde clay loam and clyde silt loam forming a large portion of the area. The acreage of onions is about equally divided between large onions and set onions, but there seems to be a tendency toward an increased acreage of sets. No special varieties of sets are grown, but the Australian browns and Ebenezer varieties are more popular than the white, due to better keeping and shipping qualities. There is little variation in cultural methods throughout the entire area. The onions are usually planted about the last week in April and cultivated and weeded from four to eight times per season. The sets are usually harvested the second week in August, depending upon variety and maturity, and placed in drying racks in the field until they can be moved into storage. Grading is done during storage in January and shipment usually commences in February. It is interesting to note here the influence which the imported onion maggot has had on one of the practices of the onion grower and his methods of handling the crop. When onions were first grown in this district, 60 pounds of seed was considered sufficient for new sets. With the increase in the number of maggots and the damage from them, a corresponding large amount of seed was planted in order to offset the maggot injury, and at the present time from 90 to 100 pounds of seed is considered necessary. A portion of the losses in sets, however, can probably be accounted for through damages by smut. At the time of harvesting, the tops of the onions are cut off and the bulbs lifted from the ground by small tractor lifters. The bulbs are then roughly cleaned to remove dirt and placed in racks in the field to dry. The tops are raked into windrows along the sides of the field and allowed to rot. The third brood of larvae is likely to be found in the stems, so this means of disposal of the crop allows the maggots to mature and to pupate either in the rotting mass or inthe soil.

Seasonal Life History

The maggot probably overwinters almost entirely in the pupal stage. However, flies were observed this year on April 11, obviously before pupae could have emerged, and farmers report onion maggot flies as early as February. This tends to the conclusion that some flies may

overwinter as adults. This year flies were first observed in numbers on April 27th around cull onions south of a store-house. The weather during March and April was cool and wet, with frequent rain and snow so that emergence of flies from overwintering pupae was slow.

The first eggs are found in spots protected from the prevailing winds which, during Spring and early Summer, range from northeast to south. east. This was clearly shown in a small area south of a store house and protected by a railroad embankment. This plot had been a dumping place for cull onions and many onions grew there after the bulk of the culls had been removed. The store house effectually cut off the winds, and eggs could be found in the protected area but not further out in the field.

The eggs hatch in 3–5 days after laying and the young larvae at once burrow into the onions. The larvae live for from 15 to 18 days in the bulbs before pupation. In small plants one maggot may injure several onions during this period. The pupae are found in the soil usually at about the level of the onion bulbs but occasionally to a depth of 5–6 inches. The last brood in the fall goes much deeper into the soil for pupation than any of the preceding broods.

The distribution of the flies in the field is an interesting study. In most of the plots of onions observed, certain localities in the plots were consistently heavily infested. These spots are usually close to the edge of the field, the center of the piece seldom being as heavily infested as near the edges. It was noticed in the spring that flies were just as numerous on potatoes as on onions, in fact, we are inclined to believe that the heavier foliage and better protection of the potatoes attracted more flies than the rank odor of the onion fields. Fly traps baited with an onion-honey-yeast bait, were scattered over the entire area about the laboratory and the largest number of flies was caught in a depression close to the railroad tracks where the trap was entirely protected from winds.

Extent of Onion Maggot Damage

There is a noticeable difference between the infestation and damage by maggot on large onions and on sets. The first brood of maggots which is the brood causing the greatest damage, does not attack the large onions to the extent that it attacks sets. There are probably two reasons for this, first, a stronger odor from the young seedlings, and, second, better protection due to the thickness of the plants in the row. At first, this seems improbable since the sets from which large onions are grown are generally planted earlier than the seed and consequently

are larger and taller at the time of early oviposition. It may be that the tough outer coating of the large onions prevents maggot injury but this argument surely does not hold for oviposition. At the same time a much larger number of eggs is usually found on the cull rows than on the nearby rows of sets. The first brood injury to sets is extensive, due to the thinning action, and the consequent larger growth of the remaining plants. This results in culls which are onions too large for sets and too small for large onions. The culls are graded out and dumped along the lake shore. The thinning action on large onions is negligible in most cases, since these onions are thinned by the growers when about half grown. The second brood of maggots does little damage, first, because the plants are larger and are able to support several maggots per plant, and, second, because a large proportion of the eggs are laid on or around plants already dying from rot or smut. There is little difference in the intensity of second brood infestation of large onions or of sets. The third brood damage is negligible since the plants are about ready for harvest at this time and have reached their maximum size.

Many pupae go into storage with the onions and may emerge there during the winter, although adults have not been found in the warehouses. As many as 40 pupae have been found in a bushel of onions recently placed in storage, although this is an exceptionally high number. The maggoty onions dry rapidly in storage and are graded out. It is doubtful if many of these pupae ever survive to emerge as adults, but the storehouses are kept slightly above freezing and it may be that this temperature is sufficient to permit emergence of a few adults.

Influences on the Crop by Factors Other than Maggot

Onion smut is very generally present throughout the entire growing region and the formaldehyde treatment is used by all growers except those west of the lake shore near Somers and the areas just west of Kenosha. Smut is now gaining a foothold in these vicinities. The treatment of smut by formaldehyde sterilizes the ground for a small area around the seed and allows the plant to get a start. Usually smut causes as much or more damage than the maggot. This dry weather just after seeding allowed the formadehyde to do its work and in most cases smut injury was negligible. On some sandy soils, drought prevented germination of the seed until it rained. In these cases the formaldehyde washed away and smut injury resulted. Neck rot and bottom rot are diseases which cause considerable damage on large onions but relatively little on sets. Maggots are nearly always found in onions affected by rot.

The past season brought out very strongly the effect of weather in connection with physiological disorders of onions. For nearly a month rain was almost continuous, fields west of the laboratory standing in two to three inches of water. The onions, where they were not submerged, grew rapidly. This rainy periods was followed by several days of extremely hot weather. On the third of July the onions looked normal. On the fifth of July they were decidedly yellow and showed dying back from the tips. One field about two miles south of the laboratory turned almost white and a close examination showed the leaves spotted very much like thrip injury. An examination of the injury by plant pathologists showed sun scald. The plants recovered in some fields but in others many plants dried down. The same trouble was found in nearly every field of sets but not in large onions.

VICE-PRESIDENT H. F. WILSON: The next paper is by H. C. Huckett.

A CONTRIBUTION TO THE STUDY OF CONTROL MEASURES FOR CUCUMBER BEETLES, *DIABROTICA DUODECIM-PUNCTATA* OLIV. AND *VITTATA* FABR.

By H. C. HUCKETT, *Riverhead, N. Y.*

ABSTRACT

In the use of nicotine dusts for cucumber beetles under controlled conditions it was found that their effectiveness was dependent on relatively dry environmental conditions, direct contact of dust with beetle, heavy applications. Under these conditions it was also found that many arsenical and non-arsenical-hydrated lime dust mixtures as well as pure hydrated lime were noticeably effective as insecticides.

Experiments in the control of cucumber beetles have been carried on on Long Island since 1923. The results have confirmed those of other workers in many respects, whilst in many details there have been significant differences due in part to the influence of local environmental conditions.

Comparative field tests of spray and dust mixtures in plant protection have indicated clearly that very few, if any, beetles were killed by such measures; nevertheless, in the case of dust mixtures, the results from those containing an arsenical were invariably superior to results obtained from the use of the inert ingredient alone. Nicotine dusts, applied to the main crop, were no more effectual in plant protection than other lime mixtures, and their killing efficiency was greatly impeded when leaves developed to interfere with contact between dust and beetles. This usually occurred when the plants were two weeks old or more. In all tests the cumulative effect of thorough applications of

dust mixtures at frequent intervals on very young plants was an important factor in retarding the growth of the plants. In this respect certain spray mixtures had a far more beneficial effect on plant growth than dust mixtures, and but for the disadvantage of cost and means of application on commercial acreages it was very evident that spray was more desirable than dust.

Nicotine and Arsenical Dusts

Preliminary experiments in the field in the use of nicotine dusts led to the accumulation of much conflicting data regarding the toxicity of such dusts to cucumber beetles. Experiments were therefore transferred to the insectary in order that certain factors determining the use of nicotine might be controlled.

The first experiment was to determine the comparative values of "contact" and "non-contact" in the application of dust mixtures to cucumber beetles.

In the case of non-contact with arsenical and non-arsenical dust mixtures, these dusts were applied lightly and thoroughly to the petiole of squash leaves, which were in turn exposed to cucumber beetles for a period of five days. Before introduction, the cucumber beetles had been without food for 24 hours. The squash petiole was kept in fresh condition by placing in a vial of water. The results are given in Table 1.

In the case of direct contact, the same dusts were applied directly to the beetle's body in light but thorough fashion. The beetles were confined during application in tubes made from wire-screening, and as soon as dusted they were transferred to similar tubes containing food, and placed on damp soil. They were retained five days for observation. The results were taken on the fifth day and are given in Table 1.

The data below clearly indicate the importance of direct contact as a factor influencing the use of arsenical or non-arsenical dust mixtures. Only in the cases where the active ingredients were used alone were dusts invariably of any value when applied indirectly. On the other hand it will be noted that pure hydrated lime had a marked lethal effect when applied directly to the body.

In testing the effect of nicotine dust on cucumber beetles exposed only to fumes of nicotine, a level teaspoonful of nicotine sulfate-hydrated lime dust of 2, 3 and 5 per cent nicotine strength was spread over the bottom of glass containers of 2000 cc. content. The containers were kept tightly stoppered for five minutes to allow the fumes to evolve. At the end of this period a wire-screen tube of three-quarter inch diameter containing a few beetles was laid across the bottom of the containers,

TABLE 1. THE EFFICIENCY OF ARSENICAL AND NON-ARSENICAL DUST MIXTURES IN KILLING CUCUMBER BEETLES UNDER CONTROLLED CONDITIONS

Dust Mixtures Ingredients		Proportions by Weight		Non-Contact		Contact	
Active	Inert	Active	Inert	Total Beetles	Per cent Dead	Total Beetles	Per cent Dead
Lead arsenate	Lime hydrate	pure	0	66	52.75	68	91.93
Lead arsenate	Lime hydrate	1	1	65	21.15	83	92.50
Lead arsenate	Lime hydrate	1	4	55	12.20	74	51.50
Lead arsenate	Lime hydrate	1	9	53	6.73	76	22.99
Calcium arsenate	Lime hydrate	pure	0	53	55.91	68	100.00
Calcium arsenate	Lime hydrate	1	1	61	28.59	84	89.91
Calcium arsenate	Lime hydrate	1	4	67	28.58	78	64.87
Calcium arsenate	Lime hydrate	1	9	57	3.99	72	51.37
Zinc arsenite	Lime hydrate	pure	0	53	3.12	95	90.16
Zinc arsenite	Lime hydrate	1	1	62	23.36	91	64.29
Zinc arsenite	Lime hydrate	1	4	56	17.63	78	49.04
Zinc arsenite	Lime hydrate	1	9	58	19.14	78	36.03
Paris green	Lime hydrate	pure	0	71	18.82	94	100.00
Paris green	Lime hydrate	1	1	42	5.00	84	88.16
Paris green	Lime hydrate	1	4	61	7.77	78	59.19
Paris green	Lime hydrate	1	9	52	9.02	73	46.20
Sodium fluosilicate	Lime hydrate	pure	0	65	82.72	86	100.00
Sodium fluosilicate	Lime hydrate	1	1	58	8.63	81	98.34
Sodium fluosilicate	Lime hydrate	1	4	49	6.00	87	64.33
Sodium fluosilicate	Lime hydrate	1	9	52	3.87	77	45.45
Calcium arsenate Monohydrated	Lime hydrate	25	55	57	9.57	74	97.08
Copper Sulfate Monohydrated	Lime hydrate	20	80	58	1.38	81	52.74
Copper sulfate	Lime Hydrate	0	pure	45	0	83	72.89
Check (fed)		—	—	47	0	79	0
Check (starved)		—	—	43	13.89	—	—

which were immediately closed for five, ten, and fifteen minute periods. The results invariably indicated that beetles were not affected by such treatment, being capable in all cases of resuming their normal activity.

In the case of direct contact, beetles were dusted with nicotine dusts under similar conditions as with arsenical and non-arsenical mixtures. They were dusted "lightly," "moderately," and "heavily," as indicated in Table 2, care being exercised that all beetles came in contact with the dust. After treatment the beetles were confined with food in wire-screen cages placed on damp sand. Temperatures during treatment ranged from 70° to 80° F. Counts were made immediately after each treatment of the number of beetles rendered inactive by contact with dust, and again after 42 hours to determine the percentage of dead beetles. The results are given in Table 2.

TABLE 2. RESULTS OBTAINED BY TREATING CUCUMBER BEETLES WITH NICOTINE-LIME DUSTS IN "LIGHT," "MODERATE," AND "HEAVY" DOSAGES

Source of Nicotine	Treatment: Per cent Nicotine content	Average Dose per Tube, gms.	Number of Beetles	Percentage of Beetles: Inactive	Revived	Dead
		"Light" Dosage				
Nicotine sulfate	2	.31	99	36.36	36.11	23.27
	3	.27	113	70.79	55.00	31.86
	5	.51	99	93.93	70.97	27.27
"Free" nicotine	1.25	.24	96	42.70	60.98	16.66
	2	.23	102	64.70	66.66	21.57
	3	.3	103	78.64	81.48	14.56
Check	–	—	20	0	0	0
		"Moderate" Dosage				
Nicotine sulfate	2	.63	110	69.09	57.89	29.09
	3	.64	118	70.34	40.96	41.52
	5	.66	103	97.08	58.00	40.77
"Free" Nicotine	1.25	.96	105	71.43	44.00	40.00
	2	.59	110	82.73	49.45	41.82
	3	.59	114	87.72	69.00	27.19
Check	–	—	21	0	0	4.76
		"Heavy" Dosage				
Nicotine sulfate	2	1.17	102	75.49	15.58	63.72
	3	1.30	114	95.61	14.03	81.58
	5	1.58	108	94.44	9.80	85.19
"Free" nicotine	1.25	.98	120	86.66	26.92	63.33
	2	1.24	113	95.57	6.48	89.38
	3	1.23	109	99.09	10.88	85.32
Check	–	—	20	0	0	0

According to the data given in Table 2 it is evident that direct contact was an important factor influencing the effective use of nicotine as well as arsenical dusts, especially when such results are compared with those obtained by exposing beetles to the indirect effect of such dusts. In the case of contact with nicotine dusts, it will be observed that with few exceptions the initial effect of all treatments was to render a high percentage of beetles inactive. This was followed by a period of considerable revival on the part of beetles that had been dusted "lightly" or at moderate dosages, with the result that the percentage of dead beetles was small in both cases. Where beetles had been "heavily" dusted there was considerably less revival, with the resultant higher percentage of dead beetles, especially in cases where dusts were used containing higher strengths of nicotine. These results indicated that heavy dosage was a necessary adjunct to contact in the lethal effect of nicotine dust on cucumber beetles.

Hydrated Lime

A third series of experiments was carried out with hydrated lime alone. According to the data given in Table 1 it will be seen that hydrated lime when brought in contact with cucumber beetles had a decided lethal effect, on the other hand when placed on the food of cucumber beetles it had no apparent adverse effect on beetles. With the object of gaining more information concerning the use of hydrated lime when dusted on beetles the following experiment was undertaken. Beetles were dusted with "light," "moderate," and "heavy" dosages of hydrated lime as indicated in Table 3. After treatment they were confined in wire-screen cages with food placed on slightly damp sand. Temperatures during treatment ranged from 72° to 77° F. Twenty-four hours after treatment the percentage of dead beetles was determined with results as shown in Table 3.

Table 3. Data Showing the Effect of Dosage in Dusting Cucumber Beetles with Hydrated Lime as Indicated by the Percentage of Dead Beetles

Treatment			
Materials	Average Dose per Tube, gms.	Number of Beetles	Percentage Dead
Hydrated lime	.30	85	45.40
	.57	88	93.63
	.95	78	97.97
Check	—	47	0

According to the data given in Table 3 it is evident that hydrated lime alone when brought into contact with beetles exerted a marked effect, especially when applied in liberal amounts.

Effect of "Moist" and "Dry" Environmental Conditions on the Lethal Properties of Hydrated Lime Dusts

The abnormally effective results produced by the application of dust mixtures with a high lime content directly on the body of cucumber beetles under controlled conditions gave rise to suspicions that factors were entering into the results that did not arise under natural conditions. Humidity was found to be one of the most important single factors qualifying such results. In experiments undertaken to obtain evidence concerning the effect of "moist" and "dry" environmental conditions on the lethal effect of hydrated lime dust mixtures, beetles that had been "heavily" dusted were exposed in wire-screen tubes containing food to environmental conditions approaching those found in the field. For instance beetles were placed in the grass on the lawn and in hay; in

damp and dry soil at the base of squash plants; on damp and dry soil at the base of squash plants; in a "moist" and "dry" chamber. In all cases beetles were kept in the shade. Temperatures during treatment ranged from 72° to 80° F. The results from these tests were taken 24 hours after treatment, and the data are presented in Table 4.

TABLE 4. THE EFFECT OF "MOIST" AND "DRY" ENVIRONMENTAL CONDITIONS ON THE LETHAL PROPERTIES OF NICOTINE DUST AS INDICATED BY THE PERCENTAGE OF DEAD BEETLES

Environmental Conditions	Per cent Nicotine Content in Dust	Average Dose per Tube, gms.	Total Beetles	Percentage Beetles Revived	Dead
On lawn grass	2	1.15	118	58.48	41.52
	3	1.15	93	56.99	43.01
	check	—	29	0	0
In hay	2	1.08	103	0	100.00
	3	1.03	123	0	100.00
	check	—	44	0	0
In damp soil	2	1.07	147	43.54	56.46
	3	1.07	152	48.02	51.98
	check	—	36	0	0
In dry soil	2	1.15	143	.7	99.30
	3	1.13	145	2.07	97.93
	check	—	40	0	0
On damp soil	2	1.07	108	84.26	15.74
	3	1.07	114	83.33	16.67
	check	—	34	0	0
On dry soil	2	1.12	94	6.38	93.62
	3	1.10	102	4.91	95.09
	check	—	36	0	0
In "moist" chamber	2	1.05	110	75.45	24.55
	3	1.07	103	54.37	45.63
	check	—	43	0	0
In "dry" chamber	2	1.13	86	0	100.00
	3	1.13	111	0	100.00
	check	—	46	0	0

From the data given in Table 4 it will be seen that the lethal effect of dust treatment was to a great extent dependent upon the presence of favourable or unfavourable environmental conditions governing the activities of the beetles. This is made evident by the extent to which beetles revived from the initial effects of treatment under relatively moist and dry conditions. These results signified that under natural conditions such factors as high atmospheric humidity, precipitation, dew, and indirectly, cracks in the soil, reduce the effectiveness of hydrated lime mixtures, whilst low atmospheric humidity, drought, and dusty conditions serve to increase their effectiveness.

In a similar series of tests it was found that the lethal effect of hydrated lime was almost entirely eliminated by the presence of "moist" environmental conditions, whilst under "dry" conditions this effect was very evident. The results from these tests are shown in Table 5.

TABLE 5. DATA SHOWING THE EFFECT OF RELATIVELY MOIST AND DRY ENVIRONMENTAL CONDITIONS ON THE LETHAL PROPERTIES OF HYDRATED LIME

Environmental Conditions	Treatment	Average Dose per Tube, gms.	Number of Beetles	Percentage of Beetles Dead After 24 Hours	48 Hours	72 Hours
On lawn grass	Hydrated lime	.35	67	0	0	2.98
		.62	112	0	0	5.35
		1.17	90	0	8.88	65.55
	None	—	60	0	0	0
In hay	Hydrated lime	.33	92	5.43	55.43	71.74
		.62	95	2.10	37.89	86.32
		1.13	74	75.67	93.24	97.29
	None	—	59	0	0	0
In damp soil	Hydrated lime	.35	78	0	1.28	1.28
		.55	69	0	1.45	1.45
		1.02	78	0	0	0
	None	—	60	0	5.00	5.00
In dry soil	Hydrated lime	.35	64	37.50	70.31	71.87
		.67	64	53.12	96.87	100.00
		1.00	88	54.54	97.73	98.86
	None	—	63	0	17.46	20.63

From the results of the foregoing experiments it may be concluded that the effective use of lime dusts was dependent on, first, relatively dry conditions, secondly, direct contact of dust with beetle, thirdly, heavy applications of dust. It was also indicated that the active principle of hydrated lime dust, whether arsenical, non-arsenical, or nicotine, was a matter of less importance, especially as conditions tended to approach the optimum for effective treatment.

VICE-PRESIDENT H. F. WILSON: The next paper is by Hugh Glasgow and J. G. Gaines.

THE CARROT RUST FLY PROBLEM IN NEW YORK

By HUGH GLASGOW and J. G. GAINES

ABSTRACT

Because of its increasing destructiveness in some of the important carrot growing sections of New York State an effective method for the control of the carrot rust fly, *Psila rosae*, has been urgently needed.

As a result of four seasons' study, at least four methods of control have been developed by which the insect may be successfully combated.

In the case of large scale operations two effective methods are available which involve comparatively slight modifications in existing cultural practices.

For the smaller grower injury may be prevented by the intelligent use of mercurous chloride preparations or by the employment of mechanical barriers such as cheesecloth screens.

INTRODUCTION

In most of the carrot growing sections of New York state the one insect pest that seriously limits the production of this crop is the carrot rust fly (*Psila rosae* Fabr.)

Ever since its introduction this insect has steadily increased in destructiveness until in some sections the production of carrots has had to be abandoned completely, while in others the appearance of the insect has rendered the growing of carrots a precarious undertaking.

A number of factors have contributed to this situation. In the first place the insect is exceedingly prolific, it appears to have few effective natural checks, while there has been no dependable artificial means of control available to the grower that could be depended on to check the increase of the pest.

The system of cropping usually followed in growing carrots, where early and late plantings may be grown in the same general locality or even in adjacent fields also has been peculiarly favorable to a rapid multiplication of the insect with a maximum amount of injury resulting to the main crop.

POINTS IN LIFE HISTORY BEARING ON CONTROL

In New York there are two main broods of the carrot rust fly with a partial third as indicated in Fig. 24.

The first brood flies, emerging from the overwintering puparia begin to appear during an average season by about May 20 and continue to emerge over a period of about a month, the emergence reaching its peak by about the first of June.

From the latter part of June for a period of nearly a month the flies are absent until the second generation begins to appear during the last

week in July. This brood continues to emerge for slightly over a month or until about the first of September, reaching its peak by about the first of August.

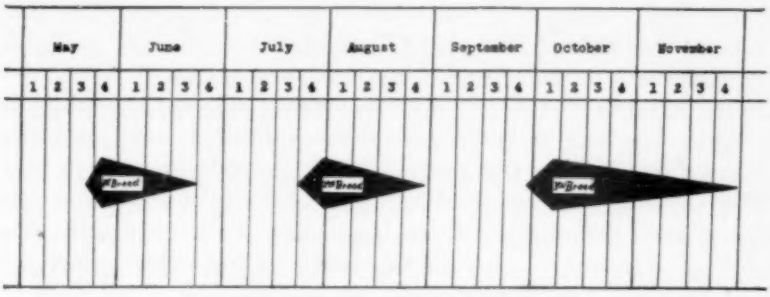

FIG. 24.—Seasonal cycle of carrot rust fly.

By the last week in September the flies of the third brood began to appear in the field and may continue to emerge until the latter part of November or even into December during open seasons.

CONTROL

Control of the carrot rust fly may be considered under four headings: Cultural practices, the application of soil insecticides directed against the immature stages of the insect, the use of poisons designed to kill the adults, and the employment of mechanical barriers to prevent oviposition.

CULTURAL METHODS

As carrots are ordinarily grown in the large carrot producing sections of the state, it is a common practice to plant a plot of carrots as early in the spring as possible, to be followed later by the main planting. Sometimes several successive plantings are made at intervals during June or July.

An understanding of the life history of the insect makes it at once apparent that this procedure may be calculated to favor the increase of the insect to maximum numbers and to result in an excessive amount of injury to the main crop of carrots which is particularly subject to attack by the second generation. The early plantings, by providing an abundant supply of food for the first generation, enables the insect to increase enormously. As a result of this unchecked increase the flies of the second generation are present in overwhelming numbers ready to attack the main crop.

Where practicable the complete elimination of all early plantings of carrots, celery or parsnips in a locality with the planting of the main crop of carrots after the middle of June should insure comparative freedom from injury. By this procedure the first brood is largely eliminated for want of host plants in which to breed, with a corresponding reduction in the numbers of the second generation.

When followed consistently in a region devoted to carrot growing such a program has been found to practically exterminate the insect and at the same time enable the grower to produce a clean crop of carrots during the same season. Where for any reason such a program cannot be carried out the alternative is to plant the main crop after the first of June and plan to harvest by the first to the middle of September during average seasons. By following this alternative method the total yield may be somewhat reduced, but if faithfully carried out it should enable the grower to produce clean carrots profitably even in districts where the rust fly is normally destructive, and it has given uniformly satisfactory results under field conditions wherever it has been tested consistently.

Spraying for the Adult

From the known feeding habits of the adult it appeared logical that thoro applications of arsenicals to the growing plants might protect the crop, as is the case of similar pests, by killing the flies before they had an opportunity to deposit their eggs.

In testing this method of control entire fields were treated thoroly with arsenicals so that the foliage was kept covered from the time the flies commenced to emerge until they had disappeared. From four to six applications were made at intervals during the season as needed.

While in some cases this method appeared to reduce the damage caused by the insect appreciably, the control on the whole was not as clear cut as had been hoped, and the method cannot therefore be recommended for the present at least.

The failure of this method may in part be accounted for by the relatively short interval that elapses between emergence of the fly and the time oviposition normally commences; and perhaps also by the fact that the fields under experimentation, while fairly well removed from other infested plantings, were not completely isolated. There may, therefore have been a slight migration of mature females from these to the treated fields. It may be that in completely isolated plantings the results from this method will be more definite.

Screening

In the case of small plantings it is possible to prevent injury by the use of tightly constructed cheesecloth screens. For this purpose a fairly closely woven fabric should be used having from 24 to 30 threads to the inch. This fabric should be supported by sidewalls made by setting boards from 6 to 12 inches wide on edge, tacking the cloth to them. These sidewalls must be tight and all openings carefully closed, as the rust fly is a small, active creature that has a greater tendency to work its way thru small openings in such a screen than some of the larger species. To be effective the screen should be in place by the time the flies first begin to appear, and should remain in place until two or three weeks before the crop is to be harvested.

Soil Insecticides

In the course of the past three seasons a large number of soil insecticides have been tested for use against the rust fly.

This list includes in part mercuric chloride solutions and dusts containing mercurous chloride, mercurous chloride in aqueous suspension, and also in the form of dusts, naphthalene preparations, various oil emulsions, derris preparations of various sorts, nicotine sulfate, tobacco dust, and others.

A number of these preparations have shown a high degree of control in the case of moderate infestations of the rust fly, but with the exception of mercurous chloride none of these have given complete protection in severe infestations without at the same time reducing the crop very appreciably as a result of injury to the foliage or root systems of the plants treated.

Mercurous chloride, on the contrary, when applied either as a dust diluted with some inert carrier such as gypsum or as an aqueous suspension is the only insecticide so far tested that has given complete control of the rust fly without at the same time seriously damaging the crop to be protected.

Conclusions

Altho properly constructed cheesecloth screens, as well as mercurous chloride applied as a dust or in aqueous suspension can be counted on to give effective control of the rust fly, the use of these methods, on account of their cost, will probably be confined chiefly to use in comparatively small plantings. In the case of large scale production the grower will probably have to depend largely on the cultural practices outlined above,

preferably on the first system discussed; or, where the application of this system is not feasible, the alternative method can be depended on to give satisfactory commercial control if intelligently carried out.

TABLE 2. COMPARATIVE VALUE OF A FEW SOIL INSECTICIDES IN THE CONTROL OF THE CARROT RUST FLY

Insecticide	Number of Applications Made and Percentage Clean Plants Obtained				
	1	2	3	4	5
Mercuric chloride, 1 oz. to 10 gallons (aqueous solution)	0	6	27	68	80
Mercurous chloride, 1 oz. to 10 gallons (aqueous suspension)	0	18	87	86	100
Mercurous chloride, 4 oz. to 10 gallons (aqueous suspension)	46	97	100	100	100
Mercurous chloride (dust)	100	100	100	100	100
Naphthalene (dust)	0	3	17	84	72
Derris (dust)	0	0	0	2	3
Lead arsenate (dust)	0	1	0	6	15
Tobacco dust	0	0	0	8	14
Bordeaux-Lubricating oil emulsion 2%	2	0	12	21	30
Check	0	0	0	0	0

The above materials were applied at weekly intervals for five consecutive weeks for the control of the second brood.

VICE-PRESIDENT H. F. WILSON: The next paper is by C. W. Collins and J. E. R. Holbrook.

CALOSOMA BEETLE TRAP

By C W. COLLINS and J. E. R. HOLBROOK, *Melrose Highlands, Mass.*

(Paper not received by editor)

MR. C. R. CROSBY: What other insects do you catch in the traps? Other beetles?

MR. C. W. COLLINS: I should have mentioned that. I didn't read from my paper, so I forgot that. There are data relative to catching other species of Calosoma. These traps have been used, so far, only in woodlands where *Calosoma sycophanta* and *Calosoma frigidum* are abundant. Hence it is an important and effective trap for these two species. *Calosoma frigidum* is also common in woodlands, some years, in connection with the gipsy moth. *Calosoma caladum* does not frequent woodlands nor are *Calosoma scrutator* and *Calosoma wilcoxi* found abundantly in woodlands of New England. There were some other species of beetles taken in the traps which were mentioned in the paper.

MR. E. G. SMYTHE: I would like to ask whether any reason has been found why the American species are not equally efficacious—whether it is a question of their ability to multiply?

MR. C. W. COLLINS: It is wholly a question of adaptability to the food at hand. The habits of the *Calosoma sycophanta*, its time of occurrence in the spring, its habitat in the woodlands and its habit of climbing in both the adult and larval stages make it more or less fitted into the habits of the gipsy moth. Hence it is an efficient enemy of that host.

VICE-PRESIDENT H. F. WILSON: The next paper is by E. P. Felt.

THE NEED FOR INVESTIGATIONS ON SHADE TREE INSECTS

By E. P. FELT, *Chief Entomologist, Bartlett Tree Research Laboratories, Stamford, Conn.*

ABSTRACT

Shade trees are left largely to shift for themselves, the forester, the horticulturist and the nurserymen holding that they should be cared for mostly by someone else, and no one has assumed much responsibility for their welfare. This, in spite of the fact that trees are important features of our recreational areas, there being nearly 13,000,000 acres in national, state, county and municipal parks and in addition millions of trees upon highways and in private grounds. The history of fruit growing in recent years demonstrates the need of artificial protection of trees from insects and fungous diseases. Depredations by the Gipsy Moth, the elm leaf beetle, the Japanese beetle and other insects indicate probable serious losses of valuable and largely irreplaceable shade trees, unless these facts are more generally recognized. A moderate proportion of the millions expended for the development and upkeep of recreational areas must be devoted to the systematic protection of trees from insect pests and fungus diseases and a comprehensive research program initiated to solve pressing needs as well as to anticipate insect depredations which experience shows may be expected in the future, if our shade trees are to be kept in a reasonably good condition.

A somewhat curious condition exists in relation to shade trees. The forester does not consider them as coming within his province. The horticulturist looks at them as somewhat in a class by themselves. The nurseryman is concerned largely with shade trees while still in the nursery row. They certainly are not fruit trees. Moreover, most people are interested in a few shade trees or at best a relatively small group and, therefore, little consideration is given to the problem as a whole.

Shade trees, however, play a very important part under present day conditions, though they, like many other blessings, are mostly taken for granted. There are large areas where shade trees or trees functioning as

shelters play a very important part. This is true of our 78 national parks or national monuments scattered throughout the United States and comprising over 10,000,000 acres. There are, in addition, some 578 state parks or equivalent areas containing over 2,500,000 acres. County parks in different sections of the country increase this by over 60,000 acres and municipal parks outside of city limits give another aggregate of over 66,000 acres. The numerous municipal parks of the country in cities of 5,000 inhabitants or more have a total area of nearly 250,000 acres. New York City, for example, has over 10,000 acres in parks, Philadelphia nearly 8,000 acres. There are, in addition to the shade trees of these areas, immense numbers of trees, some extremely valuable, in the parkways, city streets and highways of the country, not to mention private grounds. The Westchester County Park System is a notable example with some 150 miles of parkways traversing 38,763 acres and involving expenditures totaling $60,000,000. This development resulted in nearly doubling assessed valuations within a period of five years and similar conditions are recorded for county parks in northern New Jersey. Even if we grant that the trees of the national, state and some county parks may be given adequate protection by forestry methods, there are still immense numbers where higher values and sentimental and other considerations amply justify protective measures more nearly commensurate with their real worth.

The history of fruit growing in this country shows conclusively a progressively increasing need of protecting trees from insects and fungous diseases. The underlying cause is due to the readjustments necessitated by the extensive changes in the flora due to cultivation and development. Fifty years ago, an orchard could be set out with a reasonable prospect of satisfactory returns without resorting to sprays for protection from insect attack and fungous infections. This is extremely hazardous under present day conditions. We are rapidly approaching a time when similar protection must be provided for our shade trees. It is only necessary to refer to the wide spread ravages of the Gipsy Moth in eastern Massachusetts, an insect which demonstrated the possibilities of transforming within a few years thousands of acres of valuable wood lots into equal areas of brush lots, or to turn to the record of the introduced elm leaf beetle with its wide spread defoliation of highly prized elms in the northeastern United States and the consequent injury and even death of many thousands of magnificent trees. The Japanese beetle is another introduced insect presenting insistent problems for solution. Similar insect depredations, some by introduced and others by native species, may be expected in the future.

The situation, so far as shade trees are concerned, is by no means so simple and easily handled as in the case of fruit trees. There is a considerable variety of trees and shrubs among our ornamentals, some 200 species, though relatively few are planted extensively as, for example, certain maples and elms, while in many parks and private estates, there is a very miscellaneous setting with special problems constantly arising. The Arnold Arboretum, for example, has some 6500 varieties and species of trees, about 4,000 of which can be grown outdoors under New England conditions. Think for a moment of the problems involved when it comes to planting, feeding and protecting such a diverse planting.

The insistent demands of organized fruit growers and the evident connection between insect depredations and serious damage to crops has resulted in the gradual building up of organizations, both governmental and state, for the investigation of fruit growers' problems. It has been possible for a few Entomologists to give some attention to shade tree and forest insects, though for the most part, this has been incidental, and we contend that present day conditions amply justify a well-rounded progressive program for the study of shade tree insects. It is true that investigations upon fruit tree insects have made available much data which can be used to advantage in the control of shade tree pests. It is also true that the special conditions in relation to shade trees and ornamentals are such that in many cases, there must be a marked adaptation of control measures, and furthermore new problems, some very difficult, are developing and are bound to develop in the future. It is well known that methods of value in one part of the country cannot be used with equal success in another section. This has been found to be true repeatedly in the case of fruit tree insects and it certainly obtains to some extent, at least with shade tree pests.

Many millions are being expended for the development and upkeep of recreational areas, the annual expenditure for such purposes in the United States is over $30,000,000. There is no question as to the value of such activities. We do contend that the trees, although they are most valuable elements in such developments and practically irreplaceable, are seldom given the care and protection which is their due. It is not difficult to find in parks and parkways trees, sometimes many of them, in bad condition as a result of insect attack. This is especially likely to occur in the case of the more recently introduced insect pests, such as the spruce gall aphid, the satin moth and the willow leaf beetle. We know of cases where there was wholly futile spraying, such as the application of a poison after feeding for the season has ceased. Few seem to realize that the complete loss of foliage during the growing

season, means serious injury to the tree and in the case of evergreens, one stripping may kill the pine. The above are obvious troubles which are readily handled as soon as an educated public opinion insists upon adequate protection.

There are in addition numerous difficult problems, insects not at present satisfactorily controlled, which amply justify a comprehensive research program comparable to that which is being followed in relation to the insect pests of fruit trees, and one which, so far as the country as a whole is concerned is mostly wanting. It is not our purpose to suggest that insects and fungi threaten the general destruction of shade trees. We do know that there is extensive and preventable injury by both of these agents in all sections of the country, and it is our belief that the highly commendable and extensive programs for the development of adequate recreational areas and the beautifying of the vast mileage of parkways and highways of the country should be accompanied by a fuller recognition of the threat from insect hosts and fungous infections and reasonable provision made for control. There must be a research program which would forestall to some extent sudden and extensive injuries to the millions of magnificent, mostly irreplaceable shade trees on both public and private grounds.

Scientific Notes

A Collecting Vial. A remark concerning Mr. *Crowell's* communication "A vial for catching small leaping insects" in the August number, 1928.

It is strange that some of the most practical and at the same time most simple entomological equipment is not known generally. An impressive example is the so-called "mosquito-vial," a vial of the same kind as the vial proposed in the communication cited, but being made entirely out of glass; it differs from an ordinary vial only by being provided with a funnel. Vials of this kind were first applied in parasitology for catching mosquitoes, but I have used them many years for collecting very fugitive insects and especially for catching flies from the body of cattle, horses, etc.

FIG. 25.—"Mosquito vial."

The firm, Stelling, Glasfabrik, Rodingsmarkt, Hamburg, Germany, delivers them on order. The measurements wanted have to be designated.

K. FRIEDERICHS (*Rostock, now Univ. of Minnesota*).

Field Corn Injured by Larve of *Sidemia devastatrix*. On June 26th, 1928 the writers visited a corn field reported to be showing an unusual form of cutworm injury. This had been noted by the grower for a week or two prior to the time of our visit. The injury was not serious as search over five or six acres revealed less than thirty injured stalks. The injury seemed to be confined to the higher, drier portions of the field.

The corn plants which were attacked were 12–18 inches high at the time of our visit. Feeding occurred about one inch below the surface of the ground, the stalks which showed injury being almost eaten off at that point. Injured plants had fallen over or were wilted. When the ground about the base of damaged stalks was disturbed the larvae were usually uncovered.

The larvae which appeared to be mature were dirty white or gray in color, robust, 33 mm. in length, head shining reddish brown, cervical shield and anal plate, smoky brown. The larvae were caged with corn plants at the laboratory but apparently did no more feeding. Adults emerged on July 23rd. They were identified by Dr. Heinrich.

T. L. GUYTON and J. R. STEAR, *Penna. Bureau of Plant Industry*
Chambersburg, Pa.

Supella supellectilium (**Seville**), **A Household Pest in Nebraska.** During January of this year (1929) cockroaches, both nymphs and adults, of this species were collected in a house in Lincoln, Nebraska, where they were a nuisance in the kitchen and around the sink. This is the first record of this species having been taken in Nebraska. The specimens were identified by Mr. James A. G. Rehn who states that this is "a circumtropical species, previously known in the United States only from extreme southern Florida. There seems but little doubt that it reached America from the Old World by means of commerce, and there is no question but that its occurrence in Nebraska is as an accidentally introduced adventive, probably from the West Indies."

DON B. WHELAN

Correction. In an article entitled "The Development and Present Status of Entomological Courses in American Colleges and Universities," published in the December, 1928, issue of the JOURNAL OF ECONOMIC ENTOMOLOGY a number of errors have been called to the author's attention.

The University of Pennsylvania was omitted entirely from the list, which institution should have received credit for four graduate and two undergraduate courses. The University of Minnesota should be credited with eighteen courses, of which six are apiculture. The staff at Minnesota numbers 13. To the list of Canadian institutions should be added the University of Saskatchewan, University of Alberta, University of Western Ontario, Manitoba Agricultural College, and the University of Manitoba.

The main purpose in publishing this paper was to serve as an introduction to two succeeding studies, nevertheless the omissions are regretted, and thanks are extended to those kind enough to write regarding them. A more complete paper on this subject was published by Professor Roger C. Smith, in the Kansas State Agricultural College Bulletin, Volume 12, Number 1. The total institutions covered in this publication number 153. The above-mentioned embraces only ninety-nine, fifteen of which are not listed in the latter, bringing the grand total to 168. By putting the information of the two papers together a good idea of the present status and development can be obtained.

PAUL KNIGHT, *University of Maryland*

Hickory Leaf Gall Midges, *Caryomyia* **species.** A considerable series of species produce the diversified and frequently are very abundant leaf galls upon hickory. May 24, 1298, a number of females were observed at Stamford, Conn. on the leaf branchlets one to three inches long, crawling slowly upon the leaf and feeling of the surface in a somewhat spasmodic manner. After a moment, the ovipositor would be held firmly against the leaf and in one instance, the female appeared to actually pull down with her hind legs, and shortly thereafter an egg was deposited. The process took place in a second and another was laid soon after. The eggs are a pale whitish, semitransparent, about one one-hundredth of an inch long, and scattered amid the plant hairs on the underside of the leaf. There were 50 to probably over 500 eggs on individual leaflets, both upon the tightly rolled infolded ones as well as those which had presumably expanded prior to oviposition.

Nearly three weeks later, June 12th, the larger galls were about one-sixteenth of an inch in diameter, hairy, the diameter to the tips of the hairs being nearly one-eighth of an inch. The location of the gall was indicated upon the upper surface of the leaf by a slight discoloration near the point of attachment. This development is much slower than in the case of associated Phylloxera galls, and the growth of the deformity is very slow and continues practically well toward the end of September. An unexpected development in connection with the Caryomyia galls was the finding of two well differentiated ones with more or less granulate, subglobose galls and both with distinctly sticky or adhesive surfaces. One was simple, thick walled and the other thin walled, hollow and contained a thin walled, subglobular, basal cell. No insects were observed feeding upon the sticky secretion in the case of either gall.

E. P. FELT, *Stamford, Conn.*

A Valuable Aid in the Control of the Feather Mite, *Liponyssus sylviarum*. During January, 1929, a commercial poultryman near Wooster, Ohio, asked for recommendations for the control of mites. The usual program for the control of the chicken mite, *Dermanyssus gallinae*, consisting of dipping, painting and spraying houses and fixtures with a creosote and kerosene mixture, was given. This was carefully followed out but was reported by the owner as a total failure. A personal investigation then showed that the birds were literally covered with small, red mites which were later identified as the feather mite, also known as the tropical fowl mite. The attention of the owner was first called to the mites by finding them on newly laid eggs, anywhere from one to fifty or more mites being present on a single egg. This seems to be a characteristic sign of infestation. A small-scale experiment with nicotine sulphate painted on the perches as for the body louse showed that mites began to fall from the birds within fifteen minutes after the fowls settled on the roosts. Thousands of dead mites were found the following morning on white paper placed underneath the perches. The roosts in the entire house were then treated with nicotine sulphate and sulfur was dusted in all nests. The results have been most gratifying. A month has passed since the single treatment and not a living mite has as yet been observed on either eggs or fowls.

Needless to say, the above treatment will not be depended upon to completely control the mite. As soon as spring weather permits a complete program looking forward to eradication will be undertaken.

C. R. CUTRIGHT, *Associate Entomologist, Ohio Agri. Exp. Sta., Wooster, Ohio*

A Disease Differing from Wilt Observed in Gipsy Moth Larvae. During the season of 1928 the writers were conducting a series of tests on the toxicity of lead arsenate to the various larval stages of the gipsy moth. When these larvae reached the third stage there occurred in both the check and the poisoned rearing trays a heavy mortality which could not be attributed either to the result of poison or to wilt (polyhedral disease). The appearance of these larvae led the writers to suspect that *Streptococcus disparis* might possibly be the cause of death. The symptoms of the disease caused by *S. disparis* are described by Dr. R. W. Glaser in the Journal of Agricultural Research (Vol. XIII, No. 10, pp. 515–522, 1918). He states that the disease developed at the Gipsy Moth Laboratory in larvae hatched from eggs sent to him from Japan in 1915 and reports the successful establishment of the disease in a limited number of localities.

In June, 1928, several hundred dead larvae from rearing trays and from the field were submitted to Dr. Glaser now with the Department of Animal Pathology of the Rockefeller Institute for Medical Research, who reported that a few cases of wilt were present but that in most instances a gram positive Streptococcus was found which in its morphology and behavior resembled *S. disparis*.

Infection experiments were not performed, hence it is impossible to state definitely the cause of death. The presence of a disease of gipsy moth larvae differing from the polyhedral disease is of much interest. A detailed study is needed to determine fully the cause, the manner of spread, and the economic importance of the disease in the field.

DWIGHT F. BARNES and S. F. POTTS, *Gipsy Moth Laboratory, Melrose Highlands, Massachusetts*

A Tarsonemid Mite Attacking Narcissus. The writer has observed several widely scattered infestations of a *Tarsonemus* on narcissus bulbs in the United States during the past three years. In California it has been found in Humboldt, Alameda, Santa Cruz, Monterey, Los Angeles and Orange Counties; in Washington it has been found in King County. These infestations were on stock which had been grown from one to five years in their respective localities, and which included both the polyanthus and hardy types of narcissus. In addition, two cases have been observed by the writer in which heavy infestations existed on bulbs imported directly from Holland being forced in greenhouses; one of these was in Philadelphia in the spring of 1925, the other in Oakland, California, during the winter of 1925–1926. The appearance of these greenhouse infestations indicated that the mites were brought in with the shipments from Holland, for some flats showed no infestation, while others grown under the same conditions and which were traced to definite shipping crates showed almost 100 per cent infestation. It seems that the same species is involved in all cases. Dr. H. E. Ewing of the Bureau of Entomology has recently described these mites as *Tarsonemus approximatus* Banks, var. *narcissi*, in the Proceedings of the Entomological Society of Washington, Vol. 31, No. 2, February 1929, pp. 31–32.

It is thought advisable to bring this matter to the attention particularly of those inspecting narcissus bulbs, for injury by this mite may be mistaken for "leaf-and-stem" nematode (*Tylenchus dipsaca*) infestation, or for the so-called "mosaic" or stripe disease of narcissus. They injure and kill the tissues attacked by feeding and penetrating between the fleshy bulb scales. The leaves of infested plants are more or less stunted and reduced in number, and frequently show slight twisting, and may show streaks of yellowed tissue where the surfaces have been injured by feeding.

The mites remain concealed in sheltered parts of the plants, particularly in the necks of the bulbs, and occasionally in the flowers. The indications are that the mites develop slowly under cool climatic conditions in which case the injury would be scarcely discernible, while under warm conditions such as exist when bulbs are forced under glass they multiply rapidly and become so numerous that complete loss of the flower crop often results.

Preliminary tests indicate that immersion in hot water kills the mites quite readily, within one-half hour at a temperature of 110°F., and it is thought that most stocks which have been given the usual two and one-half hour treatment at 110°F. should be free from infestation. However, very little is known about possibilities of reinfestation so this mite may be found on any stocks. A decided rejuvenation has been observed in bulbs which have been cleansed of the mites.

C. F. DOUCETTE, *Assistant Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

Preliminary Report on Control of Hibernating Codling Moth Larvae. During the winter of 1927–1928 preliminary work was undertaken with the hope of finding an insecticide to kill the overwintering larvae of the codling moth. The use of an effective material would reduce the number of overwintering larvae and thus aid in shortening the summer spray schedule with avoidance of excessive arsenical residue on the fruit at harvest.

During the month of October, 1927, mature larvae collected from beneath burlap bands placed around the trunk of apple trees were allowed to spin their cocoons between strips of apple bark held together with rubber bands. These strips of bark provide conditions resembling, as near as possible, those under which the larva spins its cocoon in the field.

The strips of bark containing the larvae were treated with the materials shown in the accompanying table. With the exception of kerosene and tetrachloroethane which were used undiluted and C. P. nicotine which was diluted with water, all of the materials were used as emulsions. The formula for these emulsions was fish oil soap 2 pounds, water 1 gallon, and material being tested 2 gallons. These stock emulsions were then diluted with water to the strengths indicated in the table. The solutions were applied to the pieces of bark with a small hand sprayer. The strips of bark were thoroughly wetted so that the spray could penetrate between the bark to the cocoons; however, the cocoons were not wetted directly. Some of the materials gave off vapors but it is not known just what part, if any, the gases played in killing the insects.

After the strips of bark containing the larvae in their cocoons had been thoroughly sprayed, they were placed in an outdoor screened insectary where they were kept until the following spring and observed for moth emergence. After all moths had emerged, the strips were examined for dead larvae. The results of these tests are shown in the following table:

RESULTS OF USING DIFFERENT MATERIALS AGAINST OVERWINTERING CODLING MOTH LARVAE IN THEIR COCOONS, MOORESTOWN, N. J., 1928

Material	No. Larvae Used	No. Moths Emerged	No. Larvae Dead	Per cent Emergence
Kerosene (undiluted)	75	0	75	0
Lubricating oil emulsion, 2 per cent	74	49	25	66.2
Lubricating oil emulsion, 6 per cent	67	26	41	38.8
Lubricating oil emulsion, 10 per cent	52	26	26	50.0
Nicotine (C. P.) 1–400	54	18	36	32.6
Tetrachloroethane (technical) (undiluted)	117	0	117	0
Tetrachloroethane (technical) emulsion, 5 per cent	96	6	90	6.2
m-Nitroaniline (C. P.) emulsion, 10 per cent	55	37	18	67.2
o-Toluidine (technical) emulsion, 10 per cent	47	12	35	25.5
Aniline (technical) emulsion, 10 per cent	57	33	24	57.8
2.4 Dinitroaniline (technical) emulsion, 10 per cent	52	27	25	51.9
Nitrobenzene (technical) emulsion, 10 per cent	61	18	43	29.5
Unsprayed check	119	72	47	60.5

Of the materials tested against the hibernating larvae of the codling moth, the best results were obtained with kerosene and tetrachloroethane. No attempt is made to draw conclusions as to the practicability of utilizing these substances in codling moth control. The results serve merely as a basis for further work but it is felt that this method for reducing the over-wintering codling moth larvae could be used to advantage, provided that certain requirements were worked out satisfactorily.

L. C. MCALISTER, JR., *Bureau of Entomology, Moorestown, N. J.*

F. C. Bishopp, Bureau of Entomology, attended the meeting of the newly organized Reindeer Committee held in the office of the Commissioner of Education on January 9. Other members of the Committee from the Department of Agriculture who were present were Dr. J. R. Mohler, Chief, Bureau of Animal Industry, and Dr. Paul G. Redington, Chief, Bureau of Biological Survey. Representing the Department of the Interior on the Committee were William Spry, Commissioner, General Land Office, A. E. Demaray, National Park Service, L. A. Kalbach, Acting Commissioner, Bureau of Education, and Otto F. Ohlson, General Manager, The Alaska Railroad. The meeting was called for the purpose of discussing ways and means of aiding the growing reindeer industry in Alaska. Interest was shown in the subject of reindeer bots, which are prevalent in Alaska and do considerable damage, especially to reindeer hides.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1929

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $3.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1929–30, Des Moines; 1930–31, Cleveland; 1931–32, probably New Orleans; 1932–33, Chicago; 1933–34, undecided; 1934–35, probably Rochester.

The broader aspects of science and the tendency toward more comprehensive treatments are indicated by the reports of several committees presented at the annual meetings. The scope of the earlier committee on the United States National Museum has been broadened to include the National Museums of the country, a recognition in particular of the importance of an outstanding National collection in Canada as well as in the United States. This report strongly emphasizes the desirability of more adequate provisions for systematic studies. The adoption of this report should mean earnest support on the part of our entire membership.

The comprehensive reports on the codling moth, the European corn borer and the investigation of foreign pests, all have a broader scope than has characterized some earlier reports and are indicative of the trend of the times. There was a time when comprehensive codling moth investigations were presumably conducted by individuals. Now there is an effort to unify the studies of a series of investigators in widely separated parts of the country. In the case of the European corn borer, it is noted that for several years, these reports have been prepared with the assistance of agronomists, agricultural engineers and agricultural economists. Economic Entomology is surely broader than information about insects.

The report on the investigation of foreign pests has the same broad characteristics as the others and calls attention once more to the need long recognized of exact knowledge concerning the biology and economic importance of many insects as yet found only in other countries. There is an appendix to this report giving the expenditures in this country upon a few of the outstanding introduced insects. The problem of introduced pests and those likely to follow is an insistent one and exceedingly complex in its nature. One cannot emphasize too much the desirability of comprehensive studies in relation to the many problems bound to arise in connection with these invaders, since it is only through the possession of the fullest possible information that satisfactory solutions can be reached.

Reviews

Insect and Other Pests of Sugar Cane Chap. 6, by F. S. EARLE, pp. 162-188, in "Sugar Cane and its Culture" 256 pages. Illus. John Wiley & Sons, New York, 1928.

Henry D. Thoreau once wrote, "The Secretary of the Association for the Advancement of Science requests me, as he probably has thousands of others, by a printed circular letter from Washington the other day, to fill the blank against certain questions, among which the most important one was what branch of science I was specially interested in, using the term science in the most comprehensive sense possible. Now, though I could state to a select few that department of human inquiry which engages me, and should be rejoiced at an opportunity to do so, I felt that it would be to make myself the laughing-stock of the scientific community to describe or attempt to describe to them that branch of science which specially interests me. . . . How absurd that, though I probably stand as near to nature as any of them, and am by constitution as good an observer as most, yet a true account of my relation to nature should excite their ridicule only!" The systematic entomologist may well wonder that F. S. Earle—braver than Thoreau—should venture to write on insects, not knowing that *Lachnosterna* and *Phyllophaga* are identical, and to list the weevil borers with the moth borers, even tho he will have to admit that the errors of spelling and citation are presumably due to careless proof-reading. But the economic entomologist, and more especially the specialist in insects of sugar-cane, will rejoice to find here by far the best world-wide summary of sugar-cane insects that has ever been written, the shrewdest explanation of what the cane entomologist is trying to do and can possibly hope to accomplish, besides an estimate of the value of parasites and foreign parasite introduction that will apply to any insect problem anywhere.

The present generation, or even the preceding generation of scientists, knows little of Mr. Earle—for he is a contemporary of Dr. S. A. Forbes—and he has long been so exclusively identified with scientific tropical agriculture in the West Indies, that only the older men in the United States, or those who have had the rare privilege of working with him in his chosen environment, have an adequate appreciation of

his worth. When Director of the Station at Santiago de las Vegas, or Cane Technologist at Rio Piedras, he easily represented half the mental ability of the entire personnel, and most of what the other men did was to follow out his suggestions, even tho the work as finally reported appeared to be solely theirs. As a stimulus to associated workers he is invaluable, for in a unique way he combines the view-point of the farmer with that of the scientist, and his most casual comments are at once far-seeing and yet immediately practical. Of the present volume, he states, "Frankly, the atmosphere of the book is that of the cane field rather than that of the research laboratory."

His discussion of springtails is characteristic and typical. "The mosaic disease out-break in Porto Rico caused a determined search among the less-known and inconspicuous cane insects with the hope of finding the insect vector of this disease. One of the unexpected by-products of this study was the discovery that the one most abundant sugar-cane insect in Porto Rico had never even been noted by any of the eminent entomologists who had studied sugar-cane insects in that island, and that, when it had been found, none of the specialists could venture to name it. An undescribed species belonging to the *Thysanura*, or springtails, is still as far as we can go.

"This minute insect is present, literally by the million, in every cane field in Porto Rico, living, all stages together, on the lower side of the older leaves, or in very dry weather retreating into the enrolled bud spindle. Its minute sacrifications are the immediate cause of most of the 'ring spot' which is so common there in the older leaves.

"Such an oversight as this, of a very common, injurious species, can only be explained by the common and pernicious practice of assigning experiment station workers to too narrow a line of 'projects.' If a man is studying borers or white grubs, how can you expect him to see springtails, especially when all the authorities agree that no such animal exists on cane?"

GEORGE N. WOLCOTT, *Lima, Peru*

Current Notes

On December 12 T. L. Guyton, of Harrisburg, Pa., visited the Japanese Beetle Laboratory at Moorestown, N. J.

Plans are in preparation for a new insectary in the Department of Entomology at the University of Tennessee.

W. G. Clark, Bureau of Entomology, Assistant Chemist in the field laboratory at Tallulah, has resigned, effective January 31.

Dr. W. E. Hinds, Extension Entomologist, Baton Rouge, La., spent January 22 at Tallulah in conference with B. R. Coad.

Mr. Howard O. Deay of the University of Kansas has accepted a position as instructor in Entomology at Purdue University.

J. N. Tenhet, Bureau of Entomology, Chadbourn, N. C., visited Washington December 6 to 13, for consultation and to review literature on wireworms.

Dr. Lon A. Hawkins, of the Bureau of Plant Industry, visited the field laboratory, Bureau of Entomology, at Yakima, December 21.

On December 20, A. O. Larson,Bureau of Entomology gave a talk on bean-weevil control at Prescott, Calif., Farm Center.

John Hadjinicolon, of Athens, Greece, visited the Japanese Beetle Laboratory at Moorestown on December 15, to observe methods used in parasite work.

J. S. Houser and Geo. A. Filinger of the Ohio Agricultural Experiment Station appeared on the Farmers' Week program at Ohio State University Feb. 4–8.

Dr. C. J. Drake, of Iowa State College, Ames, spent parts of December 24 and 25 working on the National Museum collection of Heteroptera.

Walter Carter, Rodney Cecil, and W. E. Stone, Bureau of Entomology, stopped over at Washington for conference on their return from the New York meetings.

Dr. H. L. Dozier, State Entomologist of Delaware, called on January 4 to discuss with A. B. Gahan, National Museum, some problems dealing with parasitic Hymenoptera.

Professors E. O. Essig and H. B. Herms, of the Department of Entomology, University of California, at Berkeley, visited the taxonomic unit, National Museum, on January 1.

J. R Savage formerly located at the Corn-Borer Laboratory at Oak Harbor, Ohio has recently reported at Wooster where he will now be permanently located.

L. A. Stearns and R. B. Neiswander, located at the Oriental fruit moth laboratory at Ironton, Ohio, moved the laboratory and equipment to Wooster soon after March 1.

A Lecture and Laboratory Guide for Economic Entomology has recently been issued by G. M. Bentley, C. M. Wheeler and L. C. Marston, Jr., of the University of Tennessee.

A. F. Satterthwiat, Bureau of Entomology, in charge of the Cereal and Forage field laboratory at Webster, Mo., called at the Japanese Beetle Laboratory, Moorestown, December 15.

L. H. Patch, Bureau of Entomology, of the field laboratory at Sandusky, Ohio, was in Washington on January 12 for consultation regarding activities against the corn borer.

Dr. H. L. Parker, Bureau of Entomology, sailed on January 5 for Hyeres, Var, France, where he will continue to work on parasites of the European corn borer.

Dr. E. P. Felt gave an address on shade tree insects at the annual meeting of the Connecticut Tree Protective Association, held at Bridgeport, January 30.

C. S. Rude, Extension Entomologist, Oklahoma State College of Agriculture, was a visitor at Tallulah on January 18, for conference with Mr. Coad on cooperative work in Oklahoma.

On January 7 and 8 A. F. Satterthwait, of Webster Groves, Mo., completed the consultations which he began early in December with the Bureau specialists in the National Museum.

Dr. L. A. Stearns of the Ohio Agricultural Experiment Station talked to the Illinois State Horticultural Society, December 12, on the present status of the Oriental Fruit Moth.

John S. Pinckney, Bureau of Entomology, who was formerly connected with the field laboratory at Wichita, Kans., has recently been reappointed in this Division for duty at Carlisle, Pa.

Dr. Audrey Avinoff, Director of the Carnegie Museum at Pittsburgh, recently called at the Division of Insects, National Museum, to consult with Dr. Schaus and other Bureau Lepidopterists.

On January 17 Oliver I. Snapp, Bureau of Entomology, addressed the Tennessee State Horticultural Society, at Nashville, on the results of recent investigations for the control of peach insects.

E. J. Newcomer, Bureau of Entomology, of the Yakima, Wash., field laboratory, presided at the conference of the Western Cooperative Oil Spray Project, at Spokane, Wash., December 28 and 29, 1928.

Professor and Mrs. Glenn W. Herrick of the Department of Entomology of Cornell University, visited the laboratories of the Department of Entomology of the University of Illinois on February 6.

C. M. Wheeler, Iowa '26, University of Tennessee Master of Science Degree '27, First Assistant in the Department of Entomology at Tennessee, expects to spend three months this summer in Europe.

Geo. Langford working on a crop protection substitute fellowship at the Ohio Experiment Station, was in New York for a conference with members of the Crop Protection Institute on Feb. 6.

Dr. C. A. Weigel, Bureau of Entomology, delivered an address on "Insect Enemies of Carnations" before the American Carnation Society at its annual convention, held on January 30 and 31, at Lancaster, Pa.

In December, 1928, at a small mill in southern Oregon, J. E. Patterson, Bureau of Entomology, obtained records from a study of the amount of lumber salvaged from insect-killed western yellow pine.

J. L. Tate has been given an appointment as field assistant, Bureau of Entomology, at the field laboratory at Gulfport, Miss., for work on the vegetable weevil, under the direction of M. M. High.

George Sanders of the Ansbacker Chemical Company of New York City visited the University of Illinois December 15 and went over spraying experiments with W. P. Flint, Entomologist of the State Natural History Survey.

Frank Johnson, of New York City, came to Washington on January 25 to consult with Dr. Schaus and to deposit in the National Museum collection a gift of some rare species of Lepidoptera.

Frank Haimbach, of the Philadelphia Academy of Natural Sciences, visited the National Museum in December to study the collection of Pyralidae and other Lepidoptera.

Prof. Paul B. Lawson, of the University of Kansas, at Lawrence, stopped in Washington on his way to the meetings in New York City, to study Homoptera in the collection of the National Museum.

S. H. McCrory, Chief of the Division of Agricultural Engineering, Bureau of Public Roads, spent January 5 at Tallulah in conference with B. R. Coad about cooperative projects on control of the pink bollworm in the Southwest.

N. F. Howard, Bureau of Entomology, of Columbus, Ohio, attended the convention of the National Canners Association, held at Chicago, Ill., January 22 and 23, where he discussed the problem of the Mexican bean beetle.

A. W. Cressman and Miss Bessie M. Broadbent, Bureau of Entomology of the field laboratory at New Orleans, stopped in Washington for conference on their return trip from the scientific meetings in New York at holiday time.

C. M. Packard, J. R. Horton, C. C. Hill, E. D. Eaton, and A. F. Satterthwait all of the Bureau of Entomology were in Washington the first week of January for consultation on various regional problems, including that of the Hessian fly.

V. V. Williams, Assistant Entomologist, Bureau of Entomology, engaged for the past two years in investigation of the Bucculatrix in the vicinity of Calexico, Calif., resigned on January 31 to engage in commercial cotton growing in Arizona.

Professors R. K. Beamer and H. B. Hungerford, of the University of Kansas, at Lawrence, spent December 31 in the Division of Insects, National Museum, consulting with the Bureau specialists and examining material in the collection of Heteroptera.

Recent visitors at the Bee Culture Laboratory, Bureau of Entomology, included Chas. A. Reese, State Apiarist, Columbus, Ohio, Prof. L. M. Bertholf, of Western Maryland College, Westminster, Md. and W. E. Dunham, Instructor in Apiculture, Ohio State University, Columbus, Ohio.

J. S. Houser, chief of the Division of Entomology, and H. L. Gui, Assistant Entomologist, of the Ohio Agricultural Experiment Station, consulted A. B. Gahan and some of the other workers in the taxonomic unit, National Museum, early in January.

Immediately after the recent scientific meetings in New York, Prof. D. M. DeLong, of Ohio State University, visited the Insect Pest Survey, to clear up certain matters relative to the common names being used for certain common leafhoppers.

E. Rivnay, of Johns Hopkins University, Baltimore, Md., called at the National Museum December 31 to examine specimens of the beetle family Rhipiphoridae, a revision of the North American species of which he has now virtually completed.

C. F. W. Muesebeck, Bureau of Entomology, of the Gipsy Moth Laboratory, Melrose Highlands, Mass., spent December 10 to 16 in Washington, studying material relating to his work on hymenopterous parasites. He also examined some genotypes of the family Braconidae.

Prof. James S. Hine, of the Ohio State University, at Columbus, visited the National Museum on December 26 and again on December 31, looking up matters relating to his studies on the dipterous family Tabanidae, and other problems.

A. F. Satterthwait, Bureau of Entomology, of the field laboratory at Webster Groves, Mo., went to Washington early in December to discuss some of his problems with the taxonomy specialists of the Bureau and to secure identifications of material.

Merrill M. Darley, Bureau of Entomology, who for several months has been employed in the work on the alfalfa weevil at Salt Lake City, entered the Graduate School of Ohio State University at the beginning of the winter quarter.

J. L. King, Bureau of Entomology, gave one of the Ludwick Lecture Series at the Academy of Natural Sciences of Philadelphia on January 21. His subject was "The Control of Insects With Insects, and Its Application in the Philadelphia Area."

Mr. H. B. Pierson, Forest Entomologist, of the Maine Forest Service, Augusta, Me., read a paper on the "Protection of New England Forests from Insect and Plant Pests" at the Third New England Forestry Congress, held February 1–2, at Hartford, Conn.

On January 8 W. H. White, of Washington, D. C., and O. E. Cahm, of Arlington, Va., both of the Bureau of Entomology, visited Kennett Square, Pa., to confer with C. A. Thomas, who represents the Pennsylvania State College in the cooperative investigation of mushroom pests.

Ohio Agricultural Experiment Station Bulletin No. 429 "The European Corn Borer and Its Environment" is just off the press. This is an extensive publication of approximately 200 pages, giving the results of five years' work with this insect in Ohio.

I. J. Hastings has been appointed Agent, Bureau of Entomology, to take effect January 2, 1929. During the last season Mr. Hastings assisted F. P. Keen as field assistant in barkbeetle surveys on the Modoc National Forest, amd will continue work on this project.

About the middle of December, A. C. Morgan, Bureau of Entomology, Clarksville, Tenn., visited Tempe, Ariz., and other points in the Southwest, to confer with workers regarding investigations on the tobacco stalk borer, which has proven injurious to tobacco plantings in that section.

Dr. Raymond C. Osburn, head of the Department of Zoology and Entomology of Ohio State University, Columbus, Ohio, visited the Japanese Beetle Laboratory on January 1. Dr. Osburn spent some time in looking over the various branches of the work and their equipment.

Joe Milam, Bureau of Entomology, who was temporarily transferred to the Plant Quarantine and Control Administration, for work on the pink bollworm in the Southwest, returned to the Bureau on January 1, and is now assigned to the field laboratory at Tempe, Ariz.

The University of Tennessee Entomological Club continues to hold its weekly meetings each Tuesday from 5:00 to 6:00 o'clock. It has an average attendance of 38. This club is conducted as a seminar for the more advanced students in the Department of Entomology.

On December 22 Dr. H. L. Parker, Bureau of Entomology, Entomologist in charge of the field laboratory at Hyeres, Var, France, for the study of the European corn borer, visited the Japanese Beetle Laboratory at Moorestown, and was particularly interested in the parasite project there.

On his return from the scientific meetings in New York City, Prof. D. M. DeLong, of Ohio State University, Columbus, was a visitor at the Washington office, Bureau of Entomology where he called to discuss the work he has been conducting on the bean leafhopper

Dr. L. O. Howard is scheduled to give a series of addresses at the University of Illinois in April. At least one address will be popular in nature and open to the public. The other addresses of a more technical nature will be primarily for graduate students.

A. I. Balzer, Bureau of Entomology was transferred January 1 from work on the corn borer at Monroe, Mich., to take charge of a new field laboratory at Beaumont, Tex., where the main project is the study of the sugar cane moth borer as a pest of corn.

Dr. F. M. Wadley has accepted an appointment with the Insect Pest Survey, effective January 1, 1929. Dr. Wadley is a recent graduate of the University of Minnesota, and will devote part of his time to statistical work in connection with the records of the Insect Pest Survey.

Mr. Fred O. Dodd, graduate student in entomology at the University of Illinois, has accepted a position as entomological preparator with the General Biological Supply House at Chicago. He will assume his duties upon completion of his Master's Degree at the end of the present school year.

About the middle of January Walter Carter, Bureau of Entomology, returned from Washington to the field laboratory at Twin Falls, Idaho. En route he stopped at Madison, Wis., where he conferred with Prof. H. F. Wilson, J. E. Dudley, Jr., and others. At St. Paul, Minn., he conferred with Prof. R. N. Chapman and others.

Mr. George E. King, formerly graduate student and for the past year on the entomological staff of the Oklahoma Agricultural College, returned to Urbana, Ill., in October and successfully passed his examination for the degree of Doctor of Philosophy. His thesis was on the changes in the glands of the honey bee.

Gilbert A. Schenk, Bureau of Entomology, of the field laboratory at Manhattan, Kans., studying insect control in flour mills, spent a portion of December in Washington for consultation and reference work. After leaving Washington December 14, on his return trip, Mr. Schenk made stops at Harrisburg, St. Louis, and Kansas City.

On January 19, Prof. Arno Viehaver, head of the Department of Biology and Pharmacognosy at the Philadelphia College of Pharmacy and Science, and Dr. N. A. Sankowsky, Research Chemist of the Standard Oil Company, N. Y., visited the Japanese Beetle Laboratory. They were very much interested in the various branches of the work.

U. C. Loftin, of the Tlahualilo Company of Tlahualilo, Durango, Mexico, was a visitor at Tallulah January 23 and 24. Mr. Loftin was greatly interested in the work of the field laboratory there and especially in the prospects for eradication and control of the pink bollworm in Mexico and the United States.

Manuel Alcazar, Inspector de Plagas, Arduana, Juarez, Mexico, F. A. Fenton, El Paso, Tex., T. P. Cassidy, Tuscon, Ariz., and R. E. McDonald, State Entomologist, Austin, Tex., spent several days at Tallulah early in January in conference with B. R. Coad, Bureau of Entomology, regarding work on the pink bollworm in the Southwest and in Mexico.

Dr. H. W. Allen, of the Japanese Beetle Laboratory, Moorestown, N. J., spent January 9 to 18 in the National Museum perfecting manuscript which deals with the species of Tiphia occurring in eastern Asia. Records from material in the National Museum Collection not previously studied by him were incorporated in the paper at this time.

On December 1, Dr. B. A. Porter, Bureau of Entomology, formerly in charge of the field laboratory at Vincennes, Ind., was transferred to Washington, D. C., where he will act as group leader of the codling-moth investigations. Doctor Porter will also assist Dr. Quaintance in administrative work in the Office of Deciduous-Fruit Insects.

Prof. W. P. Hayes of the Department of Entomology of the University of Illinois spent the past summer in Ohio at the U. S. Department of Agriculture's Corn Borer Experimental and Demonstration Farm. He was in the employ of the Illinois State Natural History Survey and in charge of Illinois experiments being conducted on this Ohio farm.

L. C. Marston, Jr., Amherst '28, is majoring in the Department of Entomology at the University of Tennessee, Knoxville, Tennessee. O. E. Couch, University of Tennessee, '28, is also working for his Master of Science degree in the Department of Entomology. The total registration of entomological students for the first and second terms has been 75 and 48 respectively.

Howard Baker, Bureau of Entomology, who has been associated with Dr. Paul M. Gilmer in work on the codling moth in Kansas, was transferred early in January to Shreveport, La., where he will be in immediate charge of a newly established field laboratory for investigations of pecan insects. This laboratory will be a branch of the one at Albany, Ga.

Dr. E. A. Back, Bureau of Entomology, attended the meetings of the Insecticide and Disinfectant Manufacturers Association, held at Hotel McAlpin, New York City, December 10 to 13, and on December 12 showed a series of lantern slides depicting injury caused by the clothes moth, and methods of control. Doctors Roark and Redman, of the Bureau of Chemistry and Soils, also attended the meetings.

Dr. J. G. Needham, of Cornell University, spent January 23 to 29 in the Division of Insects, National Museum, working on the Chinese dragonflies in the Museum collections. With the assistance of R. P. Currie he was able to go over all of the Chinese material that had been accumulated by the Museum. He took away with him for further study several hundred specimens.

On November 27 the annual conference of the workers attached to the Bureau of Entomology field laboratory at Palo Alto was held, to review the work conducted during the field season of 1928 and to discuss plans for the work to be done in the coming winter—J. M. Miller, Dr. H. E. Burke, F. P. Keen, W. D. Edmonston, J. E. Patterson, and H. L. Person were present.

Visitors to the Gipsy-Moth Laboratory, Bureau of Entomology, in December were, December 6, L. B. Scott, in charge of the field laboratory at Silver Creek, N. Y., December 7, Dr. H. L. Parker, in charge of the field laboratory at Hyeres, Var., France, December 12, C. H. Hadley, Plant Quarantine and Control Administration, Riverton, N. J., and December 19, Dr. H. M. Tietz, Department of Zoology and Entomology, Pennyslvania State College.

Dr. Wilmon Newell, Dean of the Florida College of Agriculture and Director of the Florida Experiment Station addressed the Entomological Club and the Science Seminar at Texas Agricultural and Mechanical College, College Station, Texas, on the night of February 8 upon the subject "Present Day Trends in Entomology." Dr. Newell has just been elected President of the Association of Southern Agricultural workers for the coming year.

The Bureau of Entomology Mexican bean beetle laboratory, which was established at Birmingham, Ala., early in 1921, when the first outbreak of the beetle was discovered in the Southeast, has been closed. L. W. Brannon, who has been in charge of this laboratory, has been transferred to Norfolk, Va., where a new sublaboratory will be established, effective January 1, in cooperation with the Virginia Truck Experiment Station there.

On January 2 were terminated the appointments of N. T. Mirov and G. R. Struble, field assistants, Bureau of Entomology, who assisted H. L Person during the 1928 field season on special studies of the western pine beetle on the Modoc National forest. Mr. Struble has registered for graduate study in forestry and entomology at the University of California. Mr. Mirov will carry on some special chemical work for the office of White Pine Blister Rust Control, located at Berkeley, Calif.

C. B. Nickles, Bureau of Entomology, who has been associated with Dr. F. H. Lathrop in investigations of the blueberry maggot at Cherryfield, Me., was transferred early in January to Brownwood, Tex., where he will be in immediate charge of pecan-insect investigations there and in the vicinity. H. S. Adair, who has been in charge of the pecan-insect field laboratory at Brownwood, was transferred January 16 to Albany, Ga., where he will be associated with G. E. Moznette in investigations of pecan insects.

At the request of a commercial firm on the Pacific coast, which specializes in control of termites, J. M. Miller and Dr. H. E. Burke, of the Forest Insect Bureau of Entomology field laboratory at Palo Alto, Calif., and Professor R. W. Doane, of Stanford University, spent the afternoon of November 5 viewing one of their control operations in Palo Alto. All the soil beneath the houses under treatment is impregnated with a patented gas and all the woodwork sprayed with a patented paint. The work is apparently done thoroughly, and is guaranteed for six years.

At the Fifth National Shade Tree Conference, held at the Brooklyn Botanical Garden, February 7–8, the following entomologists were on the program: Professors J. S. Houser and W. O. Hollister, Ohio; Dr. T. J. Headlee, C. C. Hamilton and V. I. Safro, New Jersey; Professor G. W. Herrick, New York; William Middleton and H. J. MacAloney, Washington, D. C.; A. F. Burgess, Melrose Highlands, Mass.; Drs. E. P. Felt, W. E. Britton, R. B. Friend and Neely Turner, Connecticut. Other entomologists present were H. B. Weiss, Trenton, N. J., F. M. Trimble, Harrisburg, Pa., Dr. R. D. Glasgow, Albany, N. Y., Stanley W. Bromley, Stamford, Conn., and R. L. Taylor, Boston, Mass.

The Cotton States Branch of the Association of Economic Entomologists met at Houston, Texas, on February 6 and 7 for their annual meeting. A program consisting of 29 papers was presented by the members. Seventy-one entomologists were in attendance. On the night of February 6 an entomological banquet was held with 47 present at which Dr. J. W. Folsom acted as toastmaster. An excursion for those present was afforded by a special train run to the Rio Grande Valley from Houston on February 8 and 9. Many entomologists took advantage of this trip. The officers of this branch which were elected for the coming year are as follows: B. R. Coad, President, Tallulah, Louisiana; R. W. Harned, Vice-President, A. & M. College, Mississippi; O. I. Snapp, Secy.-Treas., Fort Valley, Georgia.

The fifteenth annual meeting of the Entomological Workers in Ohio Institutions was held in the Botany and Zoology Building, Ohio State University, Columbus, February 8. The program consisted of 19 papers presented by various workers. The Oriental Fruit Moth was given considerable emphasis in the program. The codling moth, the Hessian fly, and the corn borer were discussed as well as various other miscellaneous problems. Papers which received considerable comment were read by C. R. Cutright, "A Significant Feature of Biotic Potential in Insect Control;" D. M. DeLong, "Experiments with Bordeaux as a Leaf-hopper Insecticide;" and

C. H. Kennedy, "Progressive Evolution in Insects." E. G. Kelsheimer showed an interesting exhibit of preserved immature insect forms. Officers elected for 1930 meeting are: President, N. F. Howard, Bureau of Entomology; Vice-President, Alvah Peterson, Ohio State University; and Secretary, H. L. Gui, Ohio Agricultural Experiment Station.

J. M. Miller, Bureau of Entomology, in charge of the Forest Insect Field Laboratory at Palo Alto, California, accompanied by H. Basil Wales, Assistant District Forester, District 3, of the Forest Service, made an examination of the insect-control project at Prescott, Ariz., November 12 to 18. This project covers an area of 15,000 acres of yellow pine, in which the primary insect losses are due to *Dendroctonus barberi* Hopk., associated with several species of Ips. The first control work was carried out during the winter of 1927–28, and resulted in a 75 per cent decrease of losses during the following season of 1928. During the same period an increase of 300 per cent developed in adjoining areas where no control work was done. Maintenance control work on the Prescott area during the current winter was agreed upon by the Forest Service.

The annual meeting of the North Central States Entomologists and of the Central Plant Board, was held on February 28th and March 1st and 2nd, at East Lansing, Michigan, under the auspices of the Department of Entomology. At this time the Committee on Insecticides for use against corn-borer, also held a meeting which began at noon on February 27th. This group of meetings was attended by 75 members who discussed a long list of topics dealing with insect control in its various phases. An outstanding feature of the meeting was the illustrative talk given by Mr. George I. Reeves of Salt Lake City, who exhibited motion picture film and slides illustrating investigations in the control of the alfalfa weevil in the West. The next meeting was arranged to be held at Purdue University, Indiana, and all meetings in the future will begin on the first Wednesday in March and continue until Saturday.

Dr. C. I. Bliss, Bureau of Entomology, in charge of the Division's field laboratories in New Orleans and Mexico City, has been in Washington since January 3, reviewing work and plans. His principal effort during this time has been given to the handbook on experimental analysis under preparation in the Division. The first section ready for publication will deal with the analysis of field experiments on control of the codling moth. This pest has been chosen as a representative of those insects the mortality of which, as a result of control work, can not be ascertained directly; it must be gauged from the influence of the insect on the crops rather than from an actual count of living and dead individuals. Dr. Bliss's stay in Washington has grown out of the necessity of examining data kindly placed at his disposal by Dr. A. L. Quaintance, of the Division of Deciduous-Fruit Insects, and the benefits from consultation with investigators of the codling moth then in Washington. It is expected that the manuscript will be offered for publication in February.

A meeting of representatives of Stanislaus, Merced, and San Joaquin Counties, Calif., was held at Modesto December 12 to review work already done along the lines of control of the bean weevil, and to make plans for more extensive cooperation among bean growers in this portion of California. A. O. Larson and C. K. Fisher, of the Bureau of Entomology field laboratory at Alhambra, Calif., were among the speakers, and E. T. Hamlin, Horticultural Commissioner of Stanislaus County, presided. Among others present were horticultural commissioners from Merced and

San Joaquin Counties, horticultural inspectors from Mountain View, Patterson, Waterford, Oakdale, Turlock, Delhi, Manteca, and Lodi, a beet inspector from the Horticultural Department, a representative from the Turlock Chamber of Commerce, one from the Stanislaus County Board of Supervisors, who also was a member of the bean committee of the Stanislaus County Farm Bureau, one from the Agricultural Extension Service at Modesto, and representatives from two warehouse companies and a Grange Company at Modesto, from more or less similar concerns at Turlock, Merced, Hilmar, and Trinidad, and from five farm centers.

Dr. H. G. Dyar died January 21 at Garfield Hospital. He fell at his desk two days previously as the result of a stroke of some kind. Doctor Dyar was born in New York City on February 14, 1866; was educated at the Toxbury Latin School, at the Massachusetts Institute of Technology, and at Columbia University. His master's and his doctor's degrees were from Columbia. He studied at Woods Hole in the summer of 1893. He worked at first with the Lepidoptera, and published an important paper on the classification of Lepidopterous larvae in 1894. He came to Washington in 1897 and was appointed custodian of the collection of Lepidoptera in the U. S. National Museum. He succeeded the late Dr. W. H. Ashmead as Assistant Curator of the Division of Insects of the Museum. Afterwards he became connected with the Bureau of Entomology, but in his later years he worked at the U. S. National Museum as a free lance, devoting most of his attention to mosquitoes. His standing as a culicidologist was of the very highest, and he was also among the foremost lepidopterists. His death is a great loss to Washington entomological circles.—L. O. H.

A complete program of research for controlling the European corn borer was presented and adopted at the third annual conference of corn-borer interests in Washington, D. C., January 2. The meeting was attended by more than 70 representatives from the Corn Belt and the States infested by the corn borer, including entomologists, administrative officials, and others interested in the problem. Dr. A. F. Woods, Director of Scientific Work, United States Department of Agriculture, acted as chairman of the conference and opened the day's session with a brief address, in which he urged a free discussion of the many angles of the problem and explained that the purpose of the conference was to provide for a complete coordination of the various projects involving research on the corn borer throughout the affected States and Canada. The program as adopted for 1929 includes definite research work by six bureaus of the United States Department of Agriculture—Entomology, Plant Industry, Chemistry and Soils, Public Roads, Animal Industry and Agricultural Economics. Seven States—Illinois, Indiana, Michigan, Ohio, New Hampshire, Pennsylvania, and New York will also carry on research and educational work in the numerous phases of the problem. A limited number of copies of this program are available for general distribution.

On January 2, 1929, the Bureau of Entomology investigations on insects attacking ornamentals, especially bulbs, in the Northwest, were transferred from their former location at the Western Washington Experiment Station, at Puyallup, to the new field laboratory of the Division at Sumner, Wash. The relations with the Experiment Station have been most cordial, and it is only by reason of necessity that the change has been made. The Experiment Station, already cramped for room, could provide only one small office, entirely inadequate for the work. The new field laboratory is located on the grounds of the Pierce County Farm, near Sumner, and the buildings, erected for use by the County, were made possible through the efforts of the growers

in the Northwest. The laboratory plant consists of a group of buildings comprising the main laboratory, shop and storage shed, greenhouse, and insectary. The main building contains two offices, a biological laboratory, 32 by 12 feet in size, a chemical laboratory, a general laboratory room, a dark room, and a cold room. There is also a large space for storage in the unfinished upper half story. A greenhouse 26 by 80 feet is divided into two sections, with approximately 600 square feet of bench space each. The shop building, 12 by 40 feet, is divided into two parts, one to be used for shop purposes, and the other as a storage shed for bulbs or otherwise as desired. The insectary is 12 by 20 feet in size. Approximately an acre of ground is available for field tests.

A conference on the European corn borer was held at the State House, Boston, Mass., at 10:30 a. m., on Thursday, March 21, 1929. The meeting was called to order by Mr. L. H. Worthley, who outlined the purposes of the conference and described the present conditions in New England. Other speakers were Dr. A. W. Gilbert, Commissioner of Agriculture, Boston, Mass.; Professor C. O. Reed, Ohio State University, Columbus, Ohio; Messrs. D. W. Jones, C. H. Batchelder, B. E. Hodgson, and R. S. Clifton, of the United States Department of Agriculture. Others present were: W. C. O'Kane, State Entomologist and Assistant Commissioner of Agriculture, and W. A. Osgood, Durham, N. H.; Harold L. Bailey, Bradford, and Thomas Bradlin, Burlington, Vt.; F. P. Washburn, Commissioner of Agriculture, Augusta, and Melville H. McIntyre, York, Me,; Professor A. E. Stene, State Entomologist, Harry Horovitz, Alvin J. Lannon, Providence, and G. E. Adams, Extension Director, Kingston, R. I.; W. E. Britton, State Entomologist, New Haven, Conn.; S. McLean Buckingham, Commissioner of Agriculture, Hartford, Conn.; R. H. Allen, C. O. Bailey, Massachusetts Department of Agriculture, Boston, Mass.; H. N. Bartley, J. S. Stockbridge, C. W. Lewis, A. F. Burgess and S. S. Crossman of the United States Department of Agriculture.

Horticultural Inspection Notes

Mr. M. S. Yeomans has succeeded Mr. E. L. Worsham as State Entomologist of Georgia.

Mr. Perry L. Green has been appointed Commissioner of Agriculture of Ohio, the position formerly occupied by Mr. Charles V. Truax.

Mr. R. E. Montgomery recently succeeded Mr. Thomas B. Gordon as State Nursery Inspector of Oklahoma, at Oklahoma City.

Prof. H. B. Hungerford, State Entomologist for the southern district of Kansas, returned in December from a several months' trip to Europe.

Mr. H. A. Horton, who assisted at the port of Nogales, Arizona, resigned his position as junior plant quarantine inspector on February 28, 1929.

R. T. Milner has been appointed as one of the nursery inspectors of the Texas State Department of Agriculture, in place of G. E. Cannon, who has resigned.

A new item in the Federal agricultural appropriation act for the fiscal year ending June 30, 1930, provides for an appropriation of $15,000 "for the control and prevention of spread of the phony peach disease."

Mr. L. M. Scott and Mr. C. E. Cooley, of the Washington office, left Washington on March 7 for the West Coast to inspect special permit material. The trip will last approximately three months.

Mr. U. G. Haddon, who had been assisting in the Mexican Border Inspection Service at Brownsville, Texas, was transferred on January 22, 1929 to the Port of New Orleans, Louisiana.

J. M. Shott of the New Jersey State Department of Agriculture, has been appointed a collaborator with the Plant Quarantine and Control Administration to aid in the inspection of narcissus in New Jersey.

Messrs. T. H. Burris and R. T. Kyzar were transferred on February 26, 1929 from the Pink Bollworm Eradication Work to the Mexican Border Inspection Work to assist temporarily at the port of Nogales, Arizona.

Mr. Arthur B. Wells was appointed junior plant quarantine inspector at the port of New York, N. Y., February 18, 1929. Mr. Wells was employed as nursery inspector by the State of Pennsylvania from 1923 to 1926.

Mr. J. C. Pritchett, who has been employed as junior plant quarantine inspector in the Mexican Border Inspection Service at Nogales, Arizona, since July 16, 1928, was transferred on February 19, 1929 to New Orleans, La.

At a meeting of the Arkansas State Plant Board February 20, 1929, the Board's quarantine on account of the sweet potato weevil was revised so as to include the entire State of Florida in the quarantined territory.

Mr. L. A. Roberts was appointed junior plant quarantine inspector of the United States Department of Agriculture February 11, 1929, with station at El Paso, Texas. Mr. Roberts is a graduate of the Texas A. & M. College.

On November 12, 1928, Mr. W. I. Whiton, was transferred from New York, N. Y., to Washington, D. C. Mr. Whiton had been assisting at the port of New York since September 7, 1926, the date of his appointment with the Administration.

Due to the serious illness of Mr. J. T. Rogers, Inspector in Charge of the port of Charleston, S. C., Mr. Geraldus Gay was transferred on February 20, 1929, from New Orleans, La., to assume temporary charge of the work at the former port.

Mr. J. M. Del Curto, Plant Pathologist, has succeeded to the duties of Mr. R. E. McDonald as Chief of the Entomological Division of the Texas State Department of Agriculture. Mr. Del Curto's place as Chief Nursery Inspector has been filled by the appointment of Mr. J. S. Woodard.

Mr. George C. Martin was appointed junior plant quarantine inspector February 1, 1929, with station at Nogales, Arizona. Mr. Martin is a graduate of Clemson A. & M. College. Prior to coming with the Administration he was employed by the State Quarantine Department of Arizona.

On February 28, 1929 Mr. C. E. Drumheller resigned his position as assistant plant Quarantine Inspector in the Port Inspection Service. Mr. Drumheller had been assisting at the port of New York, N. Y., since September 1, 1925, the date of his appointment with the Administration.

Mr. E. C. Cotton was appointed in January as Chief of the Division of Plant Industry of the Ohio State Department of Agriculture at Columbus, to fill the vacancy created by the departure of Richard Faxon, who resigned several months previously. Mr. Cotton is a former incumbent of this office.

A hearing was held at the Agricultural Experiment Station, New Haven, Conn., February 25, regarding the revision of State quarantines concerning the gipsy moth, European corn borer, Japanese beetle, Asiatic beetle, and the establishment of a new quarantine on account of the Satin moth. Fifteen were present.

Mr. W. W. Chapman of the Philadelphia office and Mr. G. W. R. Davidson, Agent, spent the month of January in the inspection of the Plant Introduction Gardens at Chapman Field, Florida, and Savannah, Georgia. They also inspected special permit material at other points in the State of Florida.

On December 6, L. B. Smith, Bureau of Entomology, presented a paper entitled "The Japanese Beetle, Latest Recommendations for Control" before the New Jersey State Horticultural Society, in session at Atlantic City.

On December 13, Mr. Newcomer, Bureau of Entomology, read a paper at the meeting of the Montana Horticultural Society at Missoula on "Pansy Spot," an injury to apples resulting from the oviposition of thrips, and also discussed control of the codling moth.

E. J. Newcomer and M. A. Yothers, Bureau of Entomology, of the field laboratory at Yakima, Wash., attended the meeting of the Washington State Horticultural Association at Wenatchee, December 3 to 5. Mr. Newcomer read a paper on "The Codling Moth Problem in the Pacific Northwest."

During the summer and fall months 788 nurseries were inspected in the State of Tennessee. The present corps of inspectors are J. C. Moser, J. H. Kile, B. C. V. Ressler, E. P. Deuberry, S. J. McFall, C. L. Simmons, H. S. Davis and J. L. Rogers.

Mr. Horace S. Dean, who has been stationed at the port of Brownsville, Texas, since June 25, 1928, was transferred to Washington, D. C., on February 6, 1929. Mr. Dean has assumed the duties of Mr. A. J. Bruman, who resigned on January 21, 1929 to accept a position with a private concern.

A meeting of the Southern Plant Board was held at Houston, Tex., on February 5. Reports of the officers and representatives on the National Plant Board were received and discussed. Other topics considered related to the pink bollworm, the Argentine ant, the Mexican fruit worm, citrus canker, sweet potato certification and apiary inspection.

There is pending before the Missouri legislature a bill which would have the effect of transferring the plant inspection work of that State from the Missouri State Plant Board, which has administered the regulations since 1925, to the State Board of Agriculture. It is anticipated that the change will become effective before the summer nursery inspection season.

The area regulated on account of the European corn borer as designated in the Federal quarantine was extended, effective March 1, to include all of the State of Michigan and additional areas in Massachusetts, New Hampshire, Maine, Connecticut, Vermont, Pennsylvania, West Virginia, Ohio, and Indiana. The same amendment modified regulation 5 of the quarantine by discontinuing the requirement of certification with respect to packages of shelled corn weighing two pounds or less.

Messrs. Charles E. Baker, Irving S. Bowlby, Wilbur E. Bradder, Bernard A. Ganoung, Lewis W. Hodgkins, Arthur J. Lambert, Edward J. McNerney, Carl O. Peterson and Frank H. Rose have been transferred from the Bureau of Plant Industry to the Plant Quarantine and Control Administration to assist in transit inspection

during the spring nursery shipping season. Messrs. Martin E. Connolly, Concord, New Hampshire, and G. M. Whiting, Spokane, Washington, have also been appointed to the same service.

A revision of the federal satin moth quarantine, adding 172 New England towns to the regulated area, was issued in December, effective January 1, 1929. Later, in a press notice sent to horticultural journals and to the newspapers of the Pacific Northwest, the Federal Department of Agriculture called the attention of citizens of Washington State to the danger of disseminating satin moth on pussy willows and to the fact that the Federal quarantine prohibited interstate shipments of poplar and willow cuttings from the infested counties of that State.

Paul H. Millar, Chief Inspector of the Arkansas State Plant Board, reports that Arkansas is maintaining a system of terminal inspection with men stationed at the important express terminal and transfer points, for the examination of shipments of onion, cabbage, tomato and similar plants in transit. The railroads are cooperating to the extent of notifying inspectors of the arrival of freight shipments which are examined in the same manner. Whenever possible, these terminal inspectors also examine shipments of nursery stock in transit.

Mr. George G. Becker, Senior Entomologist, who has been in field charge of the Pink Bollworm and Thurberia Weevil projects of the Plant Quarantine and Control Administration since July 1, 1926, has been transferred to Washington to serve as special assistant to the Officer in Charge of the Division of Foreign Plant Quarantines, in order that closer contact may be maintained with field stations under this Division. The vacancy occasioned by the transfer of Mr. Becker has been filled by the appointment of Mr. R. E. McDonald, formerly State Entomologist of Texas.

Mr. P. A. Hoidale, on February 7, presented a paper at the Houston meeting of the Association of Southern Agricultural Workers, in which he discussed the methods employed in the highly successful eradication operations against the Mexican fruit worm, *Anastrepha ludens*. He stated that in order to aid in the enforcement of the host-free period in the infested area of southern Texas, residents of the region have voluntarily taken out 36,000 summer host fruit trees (that is, trees bearing fruit between March and October), and that only 300 such trees still remain in the area. The fruit from the latter trees will be picked while still green in order to maintain the host-free period.

The pink root disease of onions has been determined by Dr. V. H. Young, plant pathologist of the Arkansas Experiment Station and a member of the State Plant Board, to be destructive under Arkansas conditions, and that Board has declared the disease a public nuisance. The Board's inspectors stationed at the important express terminals had previously reported that from twenty-five to fifty per cent of the Bermuda onion plants shipped into Arkansas from Texas were affected with this disease. Texas plant shippers and the transportation companies were notified of the Board's ruling, and by March 1 diseased shipments had decreased to approximately 10 per cent of the total. In the meantime inspectors had either destroyed or turned back almost a million and a half diseased onion plants.

The 24th annual convention of the Tennessee State Horticultural Society was held in Nashville on January 16 and 17. The organization has a membership of more than 600. The annual winter meetings are held with a formal program and during the summer one or more day meetings are held in the leading orchard centers. The leading addresses at the recent convention were given by E. M. Prather, Field

Representative of the Tennessee State Horticultural Society; Dr. J. A. McClintock, Horticulturist of the Agricultural Experiment Station; John N. Dyer, Vincennes, Indiana; Oliver I. Snapp, U. S. Bureau of Entomology, Fort Valley, Georgia; J. L. Pelham, U. S. Bureau of Plant Industry, Albany, Georgia, and Leslie Pierce, U. S. Bureau of Plant Industry, Vincennes, Indiana. A very creditable apple show was held in connection with this convention. The newly elected officers are: L. A. Niven, President, Memphis; G. M. Bentley, Knoxville, Secretary and Treasurer.

The State of Connecticut has recently set aside several areas as blister rust control areas, within which the growing or possession of currant and gooseberry plants is prohibited. This regulation is included in State Quarantine Order No. 17, effective October 1, 1928. As a result of this measure the control area permit requirements of federal quarantine No. 63 are now applicable to the State of Connecticut and accordingly no currant or gooseberry plants or five-leafed pines may be shipped into any part of the State unless a control-area permit is attached to the container. Application for such permit should be addressed to the State Entomologist, Agricultural Experiment Station, New Haven, Conn., and should state the kind of plants to be shipped and the names and addresses of consignor and consignee. The control areas consist of 1500-foot zones surrounding certain white-pine-growing nurseries at Cromwell, Stratford, Woodmont, Deep River, New Canaan, Cheshire, Southport, Yalesville, Waterford, and West Hartford.

On March 2, the Secretary of Agriculture issued a new federal plant quarantine relating to the Asiatic beetle (*Anomala orientalis*) and the Asiatic garden beetle (*Aserica castanea*). The area quarantined comprises the vicinity of New Haven, Conn.; the southern tip of New York, including Long Island; all of New Jersey; eastern Pennsylvania; and an outlying point involving the District of Columbia and the adjacent county of Arlington, Va. The regulations under this quarantine are in general of the same nature as those recently revised and promulgated on account of the Japanese beetle, except that farm products are not brought under restriction. In connection with the announcement of the quarantine, the department reported that the Asiatic beetle has demonstrated possibilities as a lawn pest of a very menacing character, apparently much beyond that of the Japanese beetle or of any native species. The Asiatic garden beetle, in addition to being a lawn pest, was reported to have demonstrated possibilities of serious injury in the beetle stage to foliage, although in the latter capacity it has been found of less moment so far than the Japanese beetle. Administrative instructions concerning certain features of the certification of Class III nurseries under this quarantine have been issued by the Plant Quarantine and Control Administration as circular PQCA-221.

A revision of the Japanese beetle quarantine has been issued effective February 15, extending the regulated area and somewhat modifying the regulations. New territory brought under restriction includes Cecil County, Maryland (except the voting district of Cecilton); the entire District of Columbia; the city of Alexandria and Arlington County, Virginia; all of Delaware north of Sussex County and the town of Milford in that county; Rye township in Perry County, Pennsylvania; and eleven townships in the southern part of New Haven County, Connecticut. Changes made in the regulations in this revision include a slight modification of the restrictions affecting Class III nurseries and a requirement whereby shipments of farm products from New York City are brought under the same certification regulations as those which apply to the remainder of the regulated area. The interstate movement of

farm products from the District of Columbia and from the regulated area of Virginia, however, is to be unrestricted for the season of 1929, owing to the slight degree of infestation in those areas. No federal order was issued with respect to certain isolated points of Japanese beetle spread, including Hagerstown, Frederick, Cambridge and Delmar, Maryland; Lewiston and Sayre, Pennsylvania; Hartford and New London, Connecticut; Springfield, Massachusetts; and Delmar, Delaware. The Secretary of Agriculture approved the policy of treating these areas as separate control units, conditioned upon cooperation by the States concerned acceptable to the department providing for (a) nursery control under State quarantines but with Federal supervision and (b) the enforcement of cleanup operations to reduce or if possible as to certain points to eradicate the pest. Administrative instructions relative to Class III nurseries were issued by the Plant Quarantine and Control Administration on February 21 as circular PQCA-220.

The Fifth Annual meeting of the Central Plant Board was held at East Lansing, Michigan, March 1st and 2nd, 1929, the following States being represented: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio and Wisconsin. Three representatives of the United States Department of Agriculture were also present. The Board's members on the National Plant Board reported progress on securing an agreement among the regional boards on several important features of the inspection and quarantine work. A statement of Principles of Quarantine proposed by the National Board and presented for the consideration of the Central Plant Board was approved. Of special interest was the information given by Mr. George I. Reeves of the Federal Department on the present status of the alfalfa weevil in the Northwestern States. He showed that one of the important factors in the spread of the alfalfa weevil is the extensive movement of cars which have been used for the shipment of alfalfa hay, and especially cars which have double walls. Of 130 cars carrying alfalfa hay into Ogden, Utah, last summer, whose routings were traced for sixty days after leaving Ogden, sixty-six went directly into the heart of the alfalfa-growing region of the Central States. The members of the National Board were instructed to endeavor to get the cooperation of the railroads, so that only single walled cars will be used for alfalfa hay, and to secure their thorough cleansing before they are sent into the alfalfa-growing States. The Plant Quarantine and Control Administration was asked to prevent the shipment into the United States of onions infested with the lesser bulb fly; also, to extend the provisions of Quarantine No. 38 to prohibit the interstate movement of Mahonia, except *Mahonia repens* in the States which are eradicating the harmful barberries. The maintenance of the road quarantine line on the western front was commended without formal action; also, a desire was expressed that a school of instruction be held for the men who man the road quarantine line. Mr. E. G. Brewer thought that arrangements could be made to conduct these schools. Lafayette, Ind., was chosen as the next place of meeting, which will be held on March 6 and 7, 1930, and the former officers were reelected as follows: Frank N. Wallace, President; P. A. Glenn, Secretary-Treasurer; and George A. Dean and A. G. Ruggles, representatives on the National Plant Board.

Apicultural Notes

Mr. W. L. Walling, Apiary Inspector for Tennessee has organized 20 beekeeping clubs in different parts of the state.

During the year of 1928, the Kansas Entomological Commission employed 14 deputy apiary inspectors who worked in 55 counties.

In the recent agricultural appropriation bill passed by Congress an item of $7,500 was included for a chemical investigation of honey by the Bureau of Chemistry and Soils.

Mr. Jas. I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, attended the meeting of the Southern States Beekeepers' Conference held at Baton Rouge, La., on February 7–9.

The annual Short Course in Beekeeping at the New York State College of Agriculture was held during the week beginning January 28. The entire week was devoted to discussions of the various constituents and properties of honey.

Mr. Kenneth Hawkins, of the G. B. Lewis Co., Watertown, Wisc., visited the Intermountain Bee Culture Field Station of the Bureau of Entomology, at Laramie, Wyoming, on January 3, while on his way to Denver and points farther south.

The North Dakota State Legislature has just appropriated $3,000 for bee inspection work in that state. This is three times the amount that the state has been able to secure at any previous session of the State Legislature.

Dr. C. E. Burnside, of the Bee Culture Laboratory of the Bureau of Entomology, attended the meeting of the Piedmont Beekeepers' Association, at Lynchburg, Va., on January 22, and spoke on "Causes and Treatment of the Brood Diseases of Bees."

Mr. Frank Pellett, Associate Editor of the American Bee Journal, and his family and also Mr. Deyell, Manager of the A. I. Root Apiaries of Medina, Ohio, visited some commercial beekeepers in the Montgomery district of Alabama recently.

Mr. W. J. Nolan, of the Bee Culture Laboratory of the Bureau of Entomology, attended the meeting of the American Honey Institute on February 6, and the convention of the American Honey Producers' League on February 7–9. Both were held in Sioux City, Ia.

Mr. George H. Rea, who was formerly a special field agent of the Bee Culture Laboratory, of the Bureau of Entomology, recently visited the Laboratory on his way to New Bern, North Carolina, where he intends to engage in the queen-rearing and package bee business on an extensive scale.

On February 23rd there was a meeting of the Arkansas Valley Beekeepers Association in the Public Library at Wichita, Kansas. Several papers of timely interest were presented and officers were elected. Mr. Harold Sheppard of Wichita was elected president, and Mr. Chas. Dye, also of Wichita, was elected secretary.

Professor E. F. Phillips of Cornell University assisted Professor F. E. Millen in his annual Short Course in Beekeeping at the Ontario Agricultural College during the week of January 14. On the same trip he spoke to groups of employees of the T. Eaton Company, Toronto, on the sale of honey, to the Toronto Beekeepers Association and to the Guelph Rotary Club.

The beekeeping program offered by the Department of Entomology on January 17th, and 18th., as a part of the Farm and Home Week of the Illinois College of Agriculture was quite well attended. The various topics on bee behavior and management were covered by M. D. Farrar of the State Natural History Survey and Prof. V. G. Milum, Apiculturist at the University.

At a recent meeting of the Alabama Beekeepers' Association, Mr. H. C. Short of Fitzpatrick was elected President; Mr. Jasper Knight of Hayniville Vice-President; and Prof. J. M. Robinson of Auburn, Secretary and Treasurer. The program was unusually interesting since representatives of the U. S. Bureau of Entomology were present. The American Railway Express Company and the Fred Muth Mfg. Co. also took part; many phases of the queen and package bee business were discussed.

At the Convention of the Tennessee State Beekeepers' Association held in Nashville on January 18, there were about 51 enthusiastic beekeepers present. The newly elected officers are: Armstrong Allen, President, Nashville; Prof. G. M. Bentley, Secretary and Treasurer, Knoxville. At this meeting it was voted to hold two summer meetings in different bee yards of the state. Besides the State Association there is an East Tennessee Beekeepers' Association and a West Tennessee Association.

Mr. W. J. Nolan and Dr. C. E. Burnside, of the Bee Culture Laboratory of the Bureau of Entomology, attended the annual meeting of the Maryland State Beekeepers' Association, held at Baltimore on January 9, where Mr. Nolan discussed "Methods of Handling Package Bees," and Doctor Burnside discussed "Sterilization of Infected Combs by Formaldehyde," and "The Occurrence of Melezitose in Honey." Dr. H. E. Barnard, president of the American Honey Institute, was also present and gave an exceedingly interesting talk.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, returned to the Laboratory on January 26, after an extended trip through the Intermountain States, where he was engaged in a study relating to the cost of honey production and systems of apiary management. This study was carried on cooperatively by the Bureau of Entomology and the Bureau of Agricultural Economics. A number of beekeepers have been assisting in this work, by taking certain desired data.

Miss Claribel R. Barnett, Librarian of the Department of Agriculture, and Miss Mabel Colcord, Librarian of the Bureau of Entomology, visited the Bee Culture Laboratory of the Bureau of Entomology on January 24. The Laboratory houses all the literature of the Department pertaining to bees and honey, and both Miss Barnett and Miss Colcord were very much interested in plans for the further development of this collection. It is one of the leading beekeeping libraries in the country.

During the Annual Farmers' Week program held at the Ohio State University on February 6, 7, and 8, the Ohio Beekeepers' Association held its winter meeting. The speakers from out of the state were Dr. E. F. Phillips of Cornell University and Prof. R. H. Kelty, Apiculturist at Michigan Agricultural College. The record attendance during the sessions was 140. At the Business meeting the following officers were elected: President, Clyde Wheeler, Oberlin; Vice-President, Emerson Long, St. Paris; Secretary and Treasurer, W. E. Dunham, Ohio State University.

At the meeting of the American Honey Producers' League, held at Sioux City, Iowa, February 7, 8, and 9, an organization of apiary inspectors of America was perfected under the leadership of Dr. R. L. Parker, who has charge of apiary inspection for the State of Kansas. This new organization is a subsidiary of the League and

will hold its annual meetings in connection with those of the League. Its purpose is the strengthening of apiary inspection in America by working out uniform methods and regulations for the control of the brood diseases.

The Cornell Beekeeping Library has recently been considerably increased by the purchase of 334 volumes of books and journals in the German language, this having been obtained from a private collector in Vienna. Included in the lot are 36 volumes of the Eichstadt Bienen-Zeitung, the oldest of the bee-journals and the one in which many noted early authorities published their observations. Many first editions of well-known early works are also found in this collection. Arrangements have also recently been made for obtaining an extensive collection of Russian works on bee-keeping for this Library.

Mr. Yasuo Baron Goto, assistant county agent, Honolulu, Hawaii, visited the Bee Culture Laboratory of the Bureau of Entomology on January 25. Besides his duties as county agent, Mr. Goto, in partnership with his father, owns and manages one of the largest apiaries in Hawaii. Mr. Goto made it a particular point to learn as much as possible about the identification of American foulbrood, as several cases of this disease have been detected on the Islands during the past year. Mr. Goto will make a special effort to locate all sources of disease on his return to Hawaii.

The staff of the State Apicultural Research Laboratory at San Antonio was honored by a visit from Mr. J. I. Hambleton, Chief of the Apicultural Laboratory, Washington, D. C., February 3, 4, and 5. This was Mr. Hambleton's first visit to the Texas Laboratory. He expressed himself as being much pleased with the work which he found in progress. While there he arranged for a number of cooperative endeavors. The weather welcomed Mr. Hambleton to such an extent that he was enabled to see the bees working in the field and to become acquainted with some of the early flowers of Texas.

Prof. L. M. Bertholf, of Western Maryland College, Westminster, who has been engaged in research at the Bee Culture Laboratory of the Bureau of Entomology for the past few summers, visited the Laboratory on February 23 to complete some work in connection with a number of manuscripts which he is preparing for publication. While in Washington, Professor Bertholf also consulted the members of the Scientific Staff of the Bureau of Standards about his work dealing with the response of honey-bees to light of various wave-lengths, which he intends to resume at the Bee Culture Laboratory during the coming summer.

The Texas Beekeepers' Association will hold their annual spring meeting in San Antonio, April 5 and 6. The main feature of the meeting will be the presence of Miss Mary I. Barber of the Kellogg Company,who will give demonstrations in the use of honey. The report of T. W. Burleson, Delegate to the American Honey Producers League, Sioux City, Iowa; "Regulations for the Inspection for 1929" by Dr. F. L. Thomas: "The Needs of the Beekeeping Department of A. & M. College," by Dr. S. W. Bilsing; and a number of other papers will be given. Everyone interested in beekeeping is cooperating in the attempt to make this the greatest beekeepers meeting ever held in Texas.

Dr. A. P. Sturtevant, of the Intermountain Bee Culture Field Station of the Bureau of Entomology, located at Laramie, Wyoming, attended the annual meeting of the Utah State Beekeepers' Association held on January 8 and 9, at Ogden. Doctor Sturtevant reports that the meeting was well attended. Much interest was manifested in the activities of the Mountain States Honey Producers' Association, as discussed

by Mr. A. W. B. Kjosness, manager, and also in the various phases of the work of the Intermountain Bee Culture Field Station. The Utah State Beekeepers' Association went on record as favoring the passage at the present sitting of the legislature of the law under consideration prohibiting the importation into the State of bees on combs and used equipment. The Superior Honey Company held open house at their plant one day, serving lunch to all the beekeepers.

Hilje Ness, internationally known botanist, Chief, Division of Botany, Texas Agricultural Experiment Station, College Station, Texas, died December 30, 1928. Prof. Ness was not a beekeeper but had identified or verified the identification of more honey plants, than probably any other botanist. Thousands of specimens from Texas and hundreds from other parts of the world were sent to him yearly. The beekeepers have lost a wonderful friend and sympathizer. Prof. Ness was a native of Norway. He came to the United States at the age of 16. At the age of 18 he entered A. & M. College of Texas, and graduated with honors. He received higher degrees at Cornell. At the time of his death he had lived for 43 years as student, teacher and experiment station worker at the Texas A. & M. College.

During February Mr. Jas. I. Hambleton, of the Bee Culture Laboratory, of the Bureau of Entomology, visited the Bureau's Gulf Coast Laboratory at New Orleans, La., on his way to San Antonio, where he visited the Texas Apicultural Laboratory, which is located about 15 miles from San Antonio, to discuss with H. B. Parks, the director of the Station, various matters pertaining to southern beekeeping, particularly matters relating to honey plant surveys. Mr. Parks has made a very comprehensive study of the honey flora of Texas and is considered the outstanding authority on honey plants in the Southern States. On the same trip, Mr. Hambleton also visited the Intermountain Bee Culture Field Station, of the Bureau of Entomology, at Laramie, Wyoming, and discussed the experimental work for the coming season. Mr. Hambleton spent a day at the Agricultural College at Fort Collins, Colorado, where beekeeping problems of the Intermountain States were discussed with Professor Richmond. The Intermountain Bee Culture Field Station has an experimental apiary located just outside of Fort Collins, which was visited en route.

A joint meeting of the Louisiana State Beekeepers' Association and the Southern States Beekeeping Conference was held in Baton Rouge, La., on February 7-9. The meetings were held in Agricultural Hall of the University of Louisiana where the Southern States Bee Culture Field Station, of the Bureau of Entomology, is located. It was one of the best attended meetings ever held by the Southern Conference, and beekeeping representatives from most of the Southern States, as well as from a few of the Northern States were in attendance. One of the principal aims of the Conference was to bring about, if possible, the standardization of package bees. In order to expedite the establishment of standards the Conference voted unanimously to leave the matter entirely in the hands of Doctor Whitcomb and Doctor Oertel, of the Southern Bee Culture Field Station, who, after consulting with package shippers and buyers of package bees, are to draw up specifications which will be submitted to the trade for approval before being recommended as standards. The following men were elected officers of the state association: W. E. Anderson, State Entomologist, president; Rev. J. P. Cooney, vice-president; and Prof. O. W. Rosewall, secretary and treasurer, The following were elected as officers of the Southern States Conference: W. E. Anderson, Louisiana State Entomologist, president; Clay Lyle, Mississippi State Plant Board, vice-president; and Jess Dalton, St. Francisville, Louisiana, secretary.

The first annual meeting of the American Honey Institute, which was organized in March, 1928, was held on February 6, and the annual convention of the American Honey Producers' League was held on February 7–9. Both meetings were held in Sioux City, Iowa. These meetings constitute one of the best and most important gatherings of beekeepers held in this country in recent years. The attendance, which came from 19 States, taxed the hotel accommodations. A sudden spell of cold weather, however, kept away many beekeepers who were within driving distance. There were present representatives of many State beekeepers' associations, and of most of the large marketing organizations, such as the Mountain States Honey Producers' Association, the Colorado Honey Producers' Association, and the recently organized Preserves and Honey, Inc., a $5,000,000 organization for the marketing of honey, as well as various other commercial interests including commercial honey bottlers, bee supply manufacturers, tin and glass container companies, the American Railway Express Company, and the Kellogg Company. The American Honey Institute was organized by the united efforts of bee supply manufacturers and honey bottlers for the dissemination of information regarding honey in order to increase its consumption as a food by itself, in baking, and in the trades, and also to secure information as to its value in the diet and elsewhere. Membership in the Institute is now open to all, whether individuals or organizations, who are interested in the foregoing aims. The time of the American Honey Producers' League was taken up with general and business sessions. Talks were given on important questions having to do with honey and its marketing, inspection work, and special research work. The speakers included leaders in various lines of activity having to do with the honey industry. Dr. M. C. Tanquary, University Farm, St. Paul, Minnesota, is the new President; Frank Rauchfuss, Denver, Colorado, Vice-President; and Prof. J. A. Munro, State College, Fargo, North Dakota, Secretary-Treasurer.

Notes on Medical Entomology

On January 15 Mr. F. C. Bishopp, Bureau of Entomology, made a trip to Burkes Garden, Va., to make observations on conditions there as to the cattle grub.

R. W. Wells, Bureau of Entomology, returned to his station at Beltsville, Md., January 7, after several weeks spent in work on the cattle grub near Dallas and Fort Worth, Tex.

E. L. Filby, sanitary engineer for the State Board of Health of Florida, was in conference with F. C. Bishopp in Washington on January 26, regarding research work on mosquitoes in Florida.

C. D. Huyler, formerly head of the Huyler Candy Company, visited the Washington Office, Bureau of Entomology, January 7 to consult in regard to the control of wood ticks on his estate, which consists of two islands off the coast of South Carolina.

Dr. W. V. King, Bureau of Entomology, in charge of the field laboratory at Mound, La., sailed on the S. S. President Taft December 8 for Manila, where, during the next five months, he will make special studies of the Anopheline mosquitoes of the Philippine Islands. This work is to be done under the auspices of the International Health Board. Dr. King's headquarters while in the Philippines will be the Bureau of Science, Manila.